TAMPEREEN TEKNILLINEN YLIOPISTO
TAMPERE UNIVERSITY OF TECHNOLOGY

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OPPORTUNITY IDENTIFICATION FOR INDUSTRIAL DIGITAL SERVICES

Master of Science Thesis

Examiner: Prof. Miia Martinsuo
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ABSTRACT

JUSSI ESKELINEN: Opportunity Identification for Industrial Digital Services
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Identification of best concepts and ideas in the uncertain front end of innovation process presents one of the greatest challenges for any company. Opportunity identification for digital services is an increasingly important topic for industry practitioners; growing competitive pressure decreases profit which manufacturing companies achieve just by selling physical equipment and hardware. Existing scientific literature addresses industrial digital services mainly as a tool to enhance the efficiency of field service operations through mobile applications, digital services potential to widen industrial companies service product portfolio with remote services, and their impact to industrial production phases. This leaves user-centric digital services, which extend functionalities of the core product with users own digital technology, without scientific attention in an industrial context.

The primary objective of this research was to identify digital service opportunities that enhance the competitiveness of case company's equipment offering. Research methodology of this study was a multi-method qualitative action-analytical case study of a global machine manufacturer and service provider. Empirical data was collected from hundreds of digital service ideas, tens of hours' observations and by interviewing both the case company decision makers as well as benchmark industry experts.

Results of this thesis provide a methodology for digital service idea concept creation, refined digital service idea concept portfolio, identified strategic digital service opportunities and a development roadmap for the case company. This research supports existing literature, which suggests that industrial manufacturing companies have to develop new methodologies to create digital innovations. The findings show that the case company can improve the competitiveness of their equipment offering with a relatively straightforward digital service offering, which facilitates their customer's shop floor tasks. After the case company has realized the first digital service offering, it can leverage future business potential by integrating their equipment offering and people with more advanced digital service concepts.

The findings shed light on what user-centric industrial digital services are and gave reasons and tools for the case company to develop their digital service offering and concepts further. First, the case company should directly continue to validate the digital service concept with the customers and users. Also, it is suggested that the case company 1) define key product platforms which would benefit from digital service and ideate digital service concepts for them, 2) validate new digital service concepts with customers and equipment users, and 3) continue to identify low hanging fruits, build needed capabilities and realize synergies for agile digital service development.

TIIVISTELMÄ

JUSSI ESKELINEN: Mahdollisuuksien tunnistaminen teollisille digitaalisille palveluille
Tampereen teknillinen yliopisto
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Avainsanat: Teolliset digitaaliset palvelut, mahdollisuuksien tunnistaminen, digitaaliset palveluinnovaatiot

Parhaiden ideoiden ja konseptien tunnistaminen epävarmassa innovaatioprosessin alkupäässä on yksi suurimmista haasteista, jonka yritykset kohtaavat toimialasta riippumatta. Digitaalisten palvelumahdollisuuksien tunnistaminen nousee jatkuvasti tärkeämmäksi aiheeksi, kun alati kiristyvä kilpailu teollisuuden aloilla laskee pelkkien tuotteiden ja komponenttien myynnistä saatavaa voittoa. Aikaisempi tieteellinen kirjallisuus käsittelee digitaalisia palveluita pääasiassa kenttähuollon työtä helpottavina mobiilityökaluina, niiden potentiaalia uusien etäpalveluiden luomiseen ja digitaalisten palveluiden vaikutusta teollisiin tuotantoprosesseihin. Tämä jättää käyttäjälähtöiset digitaaliset palvelut, jotka lisäävät perinteisten tuotteiden toiminallisuuksia käyttäjän oman digitaalisen teknologian avulla, vaille huomiota.

Tämän diplomityön päätavoite oli tunnistaa digitaaliset palvelumahdollisuudet, jotka parantavat kohdeyrityksen laitetarjooman kilpailukykyä. Valittu tutkimusmenetelmä oli monimetodinen laadullinen toiminta-analyyttinen tapaustutkimus globaalista konepajayrityksestä, jolla on myös laaja palveluliiketoiminta. Empiirinen materiaali kerättiin sadoista digitaalipalveluideoista, kymmenistä tunneista havainnointia sekä haastattelemalla kohdeyrityksen päätöksentekijöitä sekä valitun vertailutoimialan asiantuntijoita.

Tutkimuksen tulokset tarjosivat metodologian digitaalipalveluideoiden ja konseptien luomiseen, ideakonseptiportfolion digitaalipalveluille, tunnistetut strategiset digitaalipalvelumahdollisuudet ja karkeat kehitysaskeleet kohdeyritykselle. Tämän lisäksi tulokset selventävät mitä käyttäjälähtöiset teolliset digitaaliset palvelut ovat. Löydökset tukevat olemassa olevaa kirjallisuutta, jonka mukaan teollisten valmistavien yritysten tulee ottaa käyttöön ja kehittää uusia toimintatapoja luodakseen digitaalisia innovaatioita. Kohdeyritys voi parantaa tarjoomansa kilpailukykyä melko suoraviivaisella digitaalisella palvelulla, joka tukee asiakkaiden lattiatason tehtäviä. Kehittyneemmät konseptit tarjoavat kohdeyritykselle tulevaisuuden liiketoimintapotentiaalia, jonka se voi realisoida integroimalla laitteiden ympärillä toimivat ihmiset digitaalisen palvelun avulla itse laitteeseen.

Diplomityön löydökset kertovat mitä teolliset digitaaliset palvelut ovat, ja antoi kohdeyritykselle työkaluja ja syitä niiden kehittämiseen. Ensimmäiseksi, kohdeyrityksen suositellaan jatkamaan digitaalisen palvelukonseptin validointiin asiakkaiden ja loppukäyttäjien kanssa. Seuraavaksi kohdeyrityksen tulisi 1) tunnistaa tuoteperheet, jotka hyötyvät digitaalisesta palvelusta ja luoda digitaalipalvelukonseptit niille, 2) validoida uudet konseptit asiakkaiden ja loppukäyttäjien kanssa ja 3) tunnistaa helposti realisoitavat digitaaliset palvelut, sekä mahdolliset synergiat kehitystyölle.

PREFACE

Finalizing my Master of Science Thesis means that my time at the Tampere University of Technology as a student is coming to an end. The work began at the beginning of 2017, and I wrote final words in September 2017. This project was the most challenging and rewarding part of my studies.

I would like to thank professor Miia Martinsuo for the guidance to tackle this challenging topic. Without her constructive feedback through this project, the results would not have been the same. Also, a big thanks go to the case company, especially to Olli-Pekka for making this research possible in the first place and for investing his time to guide me through the work. It was a challenge to define the scope; thus I would also like to thank Jaakko, who helped to choose the direction. Also, all people who were interviewed, gave ideas and participated in workshops, were those who made results of this study possible.

I was fortunate to have many of my friends conducting their theses at the same time as me. Thank you for the support during this project and for the great time in university. Finally, I am profoundly grateful to my close ones, whom I want to thank for endless support while writing this thesis and all the years it took to come this far.

Helsinki, 18.9.2017

Jussi Eskelinen

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ABBREVIATIONS AND NOTATIONS

PSS	Product-service system
OEM	Original equipment manufacturer
B2B	Business to business
IMS	Idea management system
ICT	Information and communications technology
CPS	Cyber-physical system
E-commerce	Electronic commerce
ID	Identification number

1. INTRODUCTION

1.1 Background

It is constantly more common to find offerings containing both solid physical core and intangible digital features. Digital service delivered along physical product can provide users information and features, which have been previously tied to their physical context (Yoo et al. 2010a). Digitalization, integration of digital technology into our everyday life through digitization of analogical data (Williams et al. 2008; Yoo et al. 2010a), is the key enabler. Examples in the consumer world of these practical, user-centric digital services are easy to find; it is possible to control speaker systems via a smartphone over a wireless network or see the temperature of food from cooking thermometer transmitting data wirelessly to a tablet computer. The interesting part is that the thermometer has no value for the user without the digital service delivering and displaying the temperature information in person's mobile device, which makes the physical device and intangible digital service interlinked and depended on each other. Existing literature is lacking empirical research, which explores the very first steps in the development process of these offerings in industrial context.

Development of information and communications technology has made offering digital service possible also in industrial context (Yoo et al. 2012; Barrett et al. 2015). Manufacturing companies have added sensors, computing power, and connectivity to their offerings (Porter & Heppelmann 2014). Already today, many industrial offerings have both physical and digital layer. Number of scholars have studied impact of digitalization to industrial production phases, remote services and technical customer service efficiency (e.g. Brax & Jonsson 2009; Yoo et al. 2012; Herterich et al. 2015b; Abrell et al. 2016), but only recently Abrell et al. (2016) confirmed that industrial manufacturing companies have to adopt new methods in order to create novel digital service innovations. Yoo et al. (2012) add that digital technology makes digital services generative – even when a lifecycle of an industrial equipment spans over decades, the intangible digital service is always possible to redesign and customize to fit the needs of specific time, place and user.

Already prior digital age, manufacturing companies, including case company of this research, have shifted their focus from solely offering products to offering also product- and customers process related services (Oliva & Kallenberg 2003). According to Parida et al. (2014), this development is progressing, and manufacturing companies have continuously increased their relative share of revenue from service activities. Oliva & Kallenberg (2003) summarized the three primary rationales for this development, which are economical, customer demand and competitive landscape. Now as companies' physical

goods and intangible service offering are getting ever more interlinked, the design phase of these product-service systems (PSSs) has gained attention (Morelli 2006). Also, it has been confirmed that manufacturing companies achieve higher profitability by directing innovation efforts to the creation of offerings, which contain both services and physical products (Eggert et al. 2015). However, the existing body of knowledge lacks how to take a customer- and user-centric approach to the front end of industrial digital service innovation. Also, the overall innovation process behind digital service development and opportunity identification is largely unexplored in the scientific literature as well in practice.

Resulting from the current state of knowledge the case company of this research, which is a large global industrial manufacturer and service provider for industrial machinery, has recognized a need to identify digital service opportunities for their equipment offering. Majority of the case company's service base is competing companies' equipment and vice versa; the case company has only a proportion of its own delivered installed base under service contracts. The case company is seeking digital services to be a differentiating factor in new equipment sales by the creation of novel non-tangible value propositions. Also, the case company sees digital services as an opportunity to maintain a connection to the proportion of their installed base, where customers are hesitant to sign a service contract along new equipment delivery. This portion of the installed base is in the hands of customers, who are either reluctant to outsource their service activities or have chosen a third-party service provider over original equipment manufacturer (OEM) service. The research settings provide a practical angle which adds to extant literature and helps the case company to determine their actions today.

The case company has digital offerings and a wide service product portfolio for customers with a service contract, which is a starting point for this project. Digital service offerings are currently monitoring based remote services and remote support, which are very much exclusive for customers with a service contract. Due to rather a narrow current digital service offering the case company does not have any digital service delivered along equipment offering to all customers. Remembering that the case company can get a service contract only to a proportion of their equipment deliveries, there is a recognized business need to identify digital service opportunities for user-centric digital services.

The empirical part of this case study will address this research problem through the identification of key elements of front end of digital service innovation, including best methodologies for digital service ideation. Research is conducted by observing the process behind the creation of dozens of digital service idea concepts, building evaluation criteria for decision making and by analyzing the gathered material to identify strategic opportunities which the digital service concepts creates for the case company. Next chapter introduces objectives of this research further.

1.2 Research objectives and problem

The objectives of this thesis are to create a framework for digital service idea concept creation, structure a digital service idea concept portfolio, identify strategic digital service opportunities as well create a development roadmap for the case company. Also, the research aims to contribute to existing innovation literature in multiple ways. First, this research creates a methodology for ideation of industrial digital services, and the findings introduce how the front end of digital service innovation happens. Finally, the research discusses how previously unknown user-centric digital service can enhance the competitiveness of an industrial equipment offering.

Existing scientific literature is reviewed first to find state of the art of industrial digital services and opportunity identification in the front end of service innovation. The theoretical section of this study also makes a connection between these by taking a holistic lifecycle centered approach to service innovation. The empirical part of this study consists data gathering from the case company, which is developing digital services meant to be bundled together with their equipment offering.

The case company has identified a business need to find differentiative value propositions to their equipment offering and an opportunity to enhance the relationship with customers, who do not choose to use case company's traditional service offerings. Now, they are aiming to fulfill the identified business need by offering digital service along with their equipment offering.

Digital service use cases in industrial context and extant literature are sparse. The reason to carry out this research, as well the underlying research problem, is lack of references and knowledge of industrial digital service opportunities. The existing body of knowledge does not provide a path to identify industrial digital service opportunities for the case company. It is straightforward to draw the main research question for this study from the research problem:

RQ: "How can the company identify digital service opportunities to enhance the competitiveness of their industrial equipment offering?"

The presented main research question is still relatively wide, and the scope needs to be further defined. Following sub-questions define the research scope and helps to answer the main research question.

1. *How can the company create digital service idea concepts for the whole life-cycle of their equipment offering?*
2. *How can the company take characteristics of their industrial equipment offering into account in digital service innovation?*
3. *How can the company evaluate the impact of digital service to competitiveness to their equipment offering?*

As previously mentioned, digital services in an industrial context are an unknown field. Multi-method research is conducted to gather rich qualitative material, and in the empirical section of this research, the gathered material is qualitatively analyzed to meet the research objectives and contribute to the extant scientific literature.

1.3 Research scope

The scope of the thesis is limited to cover the opportunity identification and front end phases of the overall innovation process, which leaves the actual digital service development out of the research scope. Followed by Yoo et al. (2010b) suggestions for digital innovation studies, this multidisciplinary research combines elements from information science, service science and industrial economics in industrial machinery manufacturing industry context.

This study is carried out without technical considerations and restrictions (i.e. the case company has adequate information systems for digital service delivery at the place, and its current installed base does not pose any restrictions). Main themes of this research are then industrial digital services, opportunity identification in the front end of service innovation and lifecycle oriented approach to assessing competitiveness through service innovation. Figure 1.1 displays the scope and focus of this research.

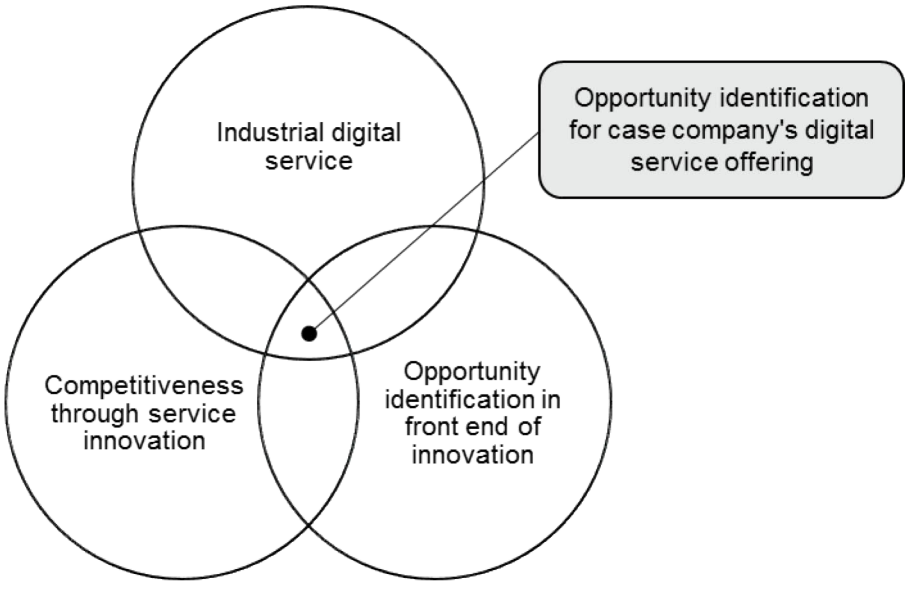

Figure 1.1: Main themes and key focus area of this research.

As the Figure 1.1 illustrates, the scope is narrowed to include extant digital service literature only from industrial offerings, which means excluding digital service literature related to consumer goods. Competitiveness through service innovation implies a holistic view which this study takes to assess how services improve the competitiveness of an industrial equipment offering. Finally, the theoretical section tries to find the answer to

the presented research questions by reviewing existing knowledge of opportunity identification in the front end of service innovation.

This research does not make a difference that is the target customers using the case company's traditional service offerings or not. After all, the whole spectrum of customers purchasing equipment would receive digital service along the equipment, regardless if they going are to make the service contract. This choice makes the results of this study more fruitful for the case company and is less known approach to existing scientific literature. The customer segment of the case company is another manufacturing company, which makes the context of this research business to business (B2B). The empirical part of this study is carried out in a situation, where the case company is innovating digital service delivered with new equipment deliveries, which clears constraints related to existing installed base machinery.

The researcher is actively working in the case company while conducting the study, which provides greater depth to the case company's situation but also means that gathered data is not completely objective. The results are also highly case sensitive due to their qualitative nature. Therefore, the results of this research are hardly generalizable in the scientific literature. Still, this study adds to the extant literature by providing insights to previously unexplored digital service innovation and shows direction for future research.

1.4 Research methodology

This thesis is a multi-method qualitative action-analytical case study, which entails features of both exploratory and descriptive research. The objectives of the study and the presented research questions direct this thesis to be hermeneutic for its philosophical view, given that in positivism the goal is to produce repeatable results, whereas hermeneutic approach emphasizes understanding and describing phenomena of interest (Olkkonen 1994). Objectives of the research are to understand and describe relatively new area for both academia and practitioners, which further indicates that hermeneutic view provides correct foundations. The chosen hermeneutic philosophical view emphasizes interpretive perspective of the social surroundings around the phenomena of interest and their relation to reality (Olkkonen 1994). Also, an interpretive researcher studies the phenomenon in its natural settings from participants' perspective (Myers 1997), which further justifies the decision to adopt interpretive perspective for this study.

Case study research strategy is a natural choice for empirical research conducted in a single organization (Ghauri & Grønhaug 2005 p. 115). Also, according to Yin (2013) case studies are carried out to understand phenomena of interest in its natural surroundings. Case studies require a thorough and rigorous analysis of selected cases (Yin 2013), and according to Gummesson (2000), they can first attempt to draw general conclusions from a limited number of cases or secondly seek to arrive at specific conclusions regarding a single case.

The selected action-analytical research approach is typically used to study internal problems of business organizations (Olkkonen 1994 pp. 72 – 73). The chosen approach provides needed a thorough understanding of the phenomena, and in action-analytical studies, a researcher can collect empirical data from a single case. The action-analytical approach aims to understand the underlying research problem through the hermeneutical view, as well conceptualize and describe the phenomenon studied. Olkkonen (1994) adds that in action-analytical research approach the researcher and the phenomena studied are typically tightly coupled. The researcher interpretations affect to the overall study, which also describes the current research. It has to be noted, that the chosen research approach places difficulties to generalize findings, and that many times the results of action-analytical are hard to test (Olkkonen 1994). However, the objectives of this research are not to produce repeatable results, which could be generalized across organizations and industries. Therefore, the weaknesses of action-analytical research approach are not critical.

A multi-method approach is selected since the empirical part of this study requires collecting and analyzing different types of data from multiple sources. Also, Yoo et al. (2010b) summarize that studies in the context of digital innovations require multidisciplinary research, including digital technology, theories of change and innovation and the actual subject field, which suggest that wider perspective is needed. They further add, that the research discipline demands an ability to interpret complex, emergent and non-linear nature of the phenomes around digital innovations, which include the emergence of new patterns and governing orders for digital innovations (Yoo et al. 2010b p. 4).

First source of empirical material is the case company's existing digital service related ideas, which the researcher retrieved from the case company's idea management system (IMS). Next, the researcher observes the front end phases of digital service innovation in the case company. Finally, selected case company employees and benchmarking industry experts are interviewed. The gathered empirical material is qualitative, which together with qualitative data analysis methods makes the results of this research entirely qualitative. The research methodology and empirical part of this study are elaborated further in Chapter 3.

Overall the selected research methodology provides a possibility to describe how decision making and digital service idea concept creation in the front end of innovation happens. According to Hirsijärvi et al. (1997), exploratory research aims to gather information about typically novel phenomena of interest and descriptive research to describe phenomena's and find causalities by modeling relationships between events, which is the case in current research.

1.5 Research process

The case company's innovation manager realized the business need to identify digital service opportunities at the end of the year 2016, which created the need to conduct current research. The research process started rapidly, already at the front end of the overall innovation process. The fast beginning was possible because the researcher worked in the case company already prior the study.

The first practical step of the research was to begin general information gathering regarding the current state of the case company's digital service offering and current development projects. After this, the researcher conducted a literature review to familiarize the topic and relevant theoretical frameworks. Empirical data gathering of this research was done at the same time as the majority of the data-analysis between the February and the June 2017. Writing of the thesis was mostly done in the July and the August 2017. Overall, the research was carried out roughly in eight months from the January 2017 to the beginning of the September 2017.

1.6 Research outline

This thesis consists three primary sections; introduction, theory and empirical examination, which further contain six individual chapters. Background, the objectives- and the research questions for the research were presented in the introduction. The first chapter also described the design and methodological foundations of this research. Figure 1.2 presents an overall outline of this thesis.

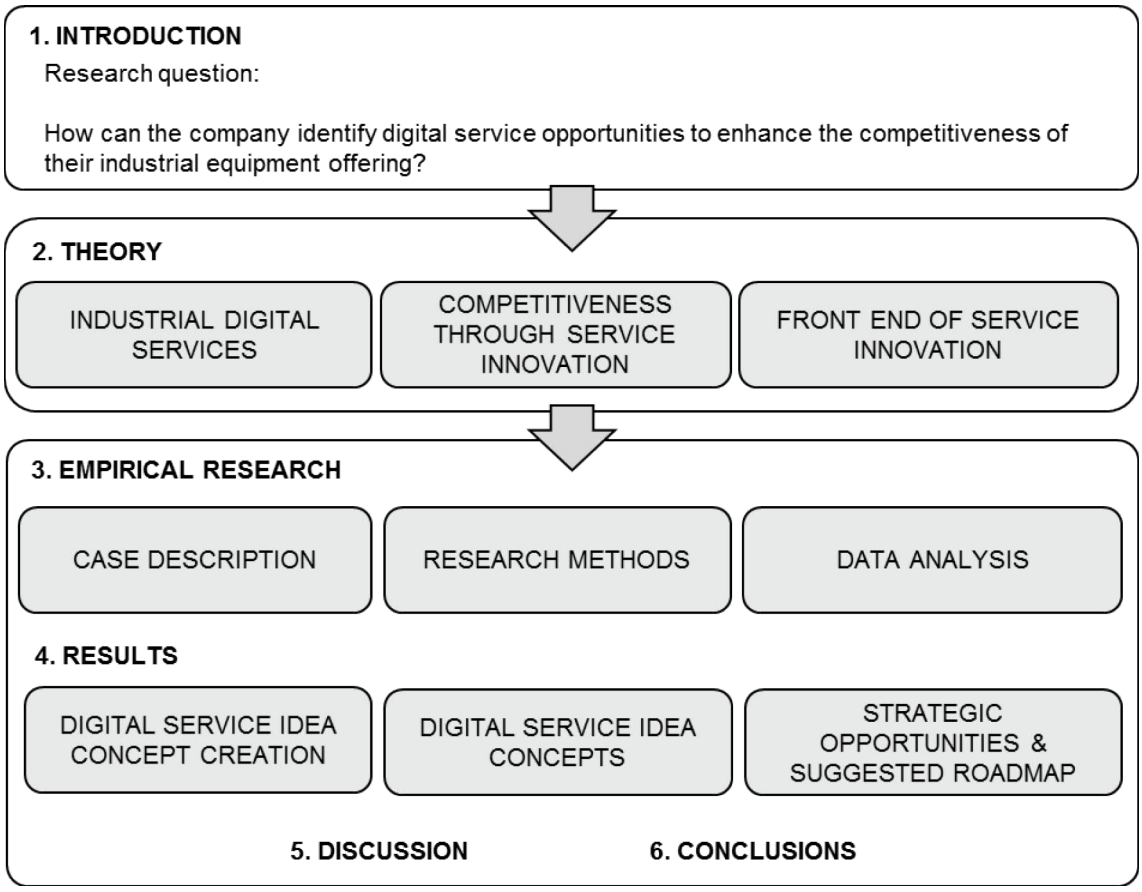

Figure 1.2: Report outline with the main content displayed.

Theoretical Chapter 2 is organized first to give an overall view of the extant literature of the research area by defining the needed terms. After this, the chapter takes an overview of industrial digital services, which lifecycle centered approach to competitiveness through service innovations follows. Next, the focus moves towards different phases of the front end of service innovation, which is the most important part of existing literature to answer presented research questions. Finally, the chapter gathers insights from existing scientific literature to draw a synthesis and basis of the empirical research.

The empirical part of the study begins in Chapter 3 with introduction to the case company. The chapter also describes used research methods for empirical data collection and data analysis. Next, Chapter 4 presents the results of the empirical examination. Chapter 5 answers to the presented research questions, draw a synthesis between existing theory and the findings of this research, as well evaluates the results of this thesis. The final Chapter 6 begins with conclusions of the research and continues to evaluate this research form higher perspective. The thesis ends by presenting possible themes for future studies.

2. DIGITAL SERVICE OPPORTUNITIES

The purpose of this chapter is to review extant scientific literature, which is related to this research scope. The chapter begins by introducing important terms and their definitions. The end of the theoretical section also synthesizes existing scientific knowledge to form the starting point for empirical part of this research.

2.1 Terms and definitions

The objective of this research is to identify digital service opportunities, which makes it necessary to understand what services in general are. Services are physically intangible, they are activities and not physical things, and services are consumed at the same time as created (Grönroos 1982 p. 31). Fitzsimmons & Fitzsimmons (2008) adds that services are also heterogeneous and customers are involved in the service process. However, traditional services and digital services are not alike. The four main differences between digital and traditional service are: the sense of intangible and tangible is different, digital services are typically some coordination of physical activity, the concept of ownership is different, and finally, at least a portion of the interaction is digital, making digital service more homogenous than traditional service (Williams et al. 2008). Digital service in this study is an activity or benefit, which one party can provide to another through a digital interaction (Williams et al. 2008). The differences between digital and traditional service are rooted to use of digital technology for service delivery.

Use of digital technology for digital service delivery makes it essential to define the term further. According Yoo et al. (2010a), main features of digital technology are considered to be an ability to homogenize analogical data into digital form, capability to be reprogrammable to complete versatile tasks, which may exceed the intended original functionality of a device and self-referential nature, which means that digital innovation requires the use of digital technology. These key features of digital technology firstly make digital data homogenous by its nature, even if it originates from heterogeneous sources, secondly allows digital devices to complete a wide array of tasks and finally requires that all digital service innovations involve utilization of digital technology (Barrett et al. 2015).

The unique features of the digital technology fuel digital service innovation. This study defines digital service innovations as novel combinations of digital features, digital technology and physical components (such as traditional service and physical devices), which together form novel digital services (Lusch & Nambisan 2015). Innovation means for the case company the creation of a new, viable business offering. In more details, innovations are new for the case company and create value, which influences the case

company's financial performance. The concept of digital service innovation is one of the key areas of this study, as the empirical section of the research is carried out by following front end phases of digital service innovation in the case company.

There are many conceptualizations regarding the content of the front end of innovation (e.g. Koen et al. 2001; Alam 2006; Frishammar et al. 2016). Koen et al. (2001) defined the front end of innovation as the phases and the steps which happen before a formal development project, and their definition is also used in the present study. Even though they described the "fuzzy" front end based on empirical findings that companies take before product development projects, it still captures what in practice happens in the case company prior formal digital service development.

Identification of strategic opportunities in the front end of innovation is also needed to define for this study. The case company of this research is expecting that offering digital services along their equipment offering enhances both competitiveness of their equipment as well creates future business potential. Martinsuo & Poskela (2011) defines a strategic opportunity in the front end of innovation as evaluated competitive advantage and future business potential of new a concept. This definition encompasses the goals of the case company which makes their definition of the strategic opportunity fit well for the present study, even though their research focused on the evaluation of strategic opportunities in the front end of product innovation.

Successful digital service concepts created in the front end of innovation should create value for companies and their customers, which makes it essential to define further how digital services facilitate value creation. This study defines value as value-in-use, and digital services would be facilitating customer's value creation along the case company's equipment offering. Therefore, the current study adopts service-dominant logic and defines it following Vargo & Lusch (2004) conceptualization and emphasizes the view that physical products are distribution mechanism for digital service offering.

2.2 Industrial digital services

2.2.1 Servitization in digital age

The term servitization is used to describe a phenomenon when previously product-centric manufacturing companies are increasing their focus towards service business (Oliva & Kallenberg 2003). Servitization has gathered a solid body of scientific literature, especially from the last two decades (Baines et al. 2017). Baines et al. (2017) conducted a systematic literature review of service literature to guide researchers towards novel research areas. Their research shows that currently the influence of disruptive innovation, as well changing aspects of technology shift on servitization, has not been developed to understanding, indicating that digital services are still today unknown field for academia.

Still, servitization literature can lay the foundation and root current research to existing literature.

In the scope of this research disruptive innovations and technology change roots to the utilization of digital technology to digital service delivery. Lerch & Gotsch (2015) studied German-based manufacturing companies' transformation in two dimensions, from solely manufacturing organization to PSS provider and the utilization of digital technology in their offerings and processes. Even though the digitalization – servitization framework, which Figure 2.1 presents, is based on single research by Lerch & Gotsch (2015), it manages to root the empirical part of this study to servitization transformation.

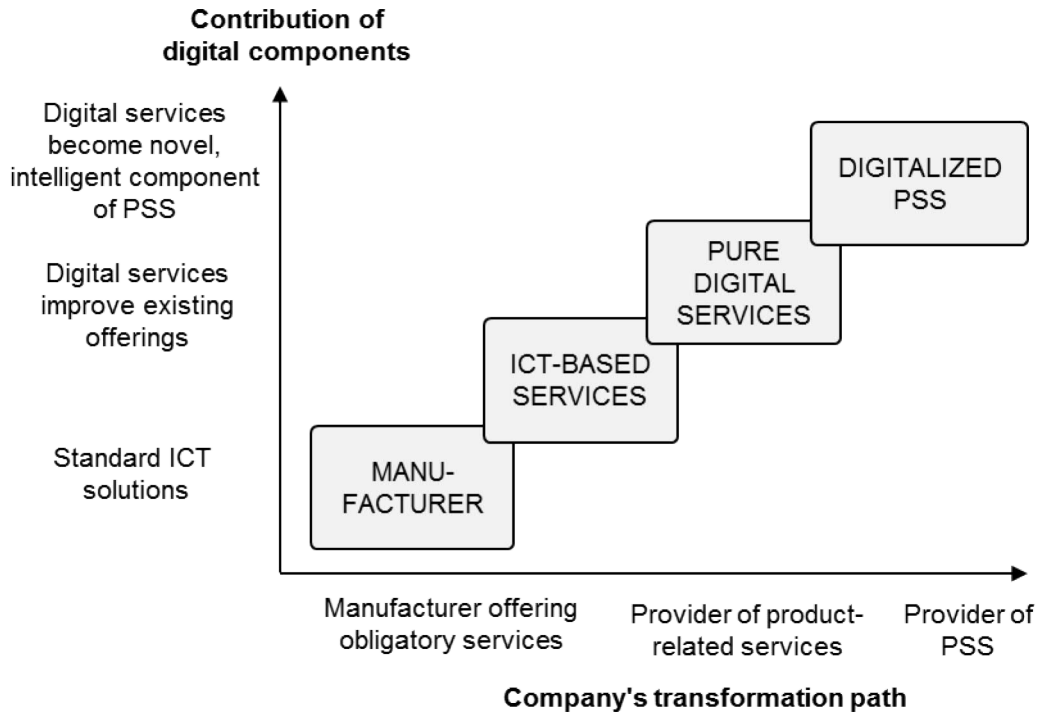

Figure 2.1: Digitalization – servitization transformation (adapted from Lerch & Gotsch 2015, p. 47).

Lerch & Gotsch (2015) identified four distinct stages when industrial companies are transforming both to a digitalized organization, but also towards outcome offerings. These stages are:

1. *Manufacturer:* At the first stage manufacturers provide necessary product-related services and use standard information and communication technology (ICT) -solutions to support their processes (e.g. supporting digital services such as digital text files, e-mail, and video conferencing)
2. *ICT-based services:* At this stage, manufacturers use ICT-solution to enhance existing service offering and widen service portfolio (e.g. remote services, such as remote monitoring and controlling equipment over distance)

3. *Pure digital services:* By the third stage, manufacturers offer novel digital services enabled by digital technology, which extends companies service offerings and improves the performance of the existing equipment offerings (e.g. virtual- and augmented reality applications as well software-based simulations)
4. *Digitalized PSS:* At final stage, manufacturers offer a complex PSS, which includes digital technology as a novel component in their offerings (e.g. new business models which deliver outcomes and optimize resource usage)

The most interesting stage for this research is when manufacturing companies are offering pure digital services. The case company is already offering ICT-based services, and now is extending its pure digital service offering. The final phase, digitalized PSS, could also be seen relevant for this research since digitalized PSSs resembles cyber-physical systems (CPSs), which are smart, connected industrial systems consisting machines and are connected to surrounding systems and people (Herterich et al. 2015b). However, CPS research today provides only a high-level conceptualization of required actors for delivering digital services. Therefore, the key focus of this research is pure digital services, which are reviewed further next.

2.2.2 Digital services

The focus of the current research is to identify digital service opportunities, which would enhance the competitiveness of the case company equipment offering. These digital services would be utilizing digital technology (i.e. mobile devices and computers) owned by the customers and the users. After all, offering and utilization of digital service require the use of digital technology, since digital services are activities or benefits provided through digital transactions (Williams et al. 2008; Yoo et al. 2010b). Therefore, this chapter introduces the key elements of digital technology and digital services linked to the scope of this study.

Digital technology has three main features which facilitate digital service innovation opportunities; homogenization of digital data, re-programmability, and self-referential nature (Yoo et al. 2010a pp. 725 – 727). The homogenization of digital data means that a digital representation of any analog signal is a set of binary numbers, which makes all digital content (such as audio, video, text, and image) homogenous, even if it originates from heterogeneous sources. This feature allows digital data to be stored, transmitted, processed and displayed using any digital device and network. Also, digital data can be combined with other digital data, which further facilitates digital service innovation even over industry boundaries (Barrett et al. 2015; Lusch & Nambisan 2015). The re-programmability of digital technologies makes it possible for a digital device to complete a wide array of tasks (for example, to calculate distances, process written language, edit and display videos and browse the internet). Finally, self-referential nature of digital technologies means that digital services require the use of digital technology (such as computers or smartphones).

In more details, digital technologies consist four generic layers. First, device layer contains hardware and operating systems; second network layer governs logical transmission and physical transport; third service layer offers functionality for a specific application(s), which serve the users of devices when contents are stored, manipulated, created and consumed. Finally, the fourth content layer encompasses data and information, which is presented to the user (Yoo et al. 2010a). Figure 2.2 presents the layered architecture of digital technologies.

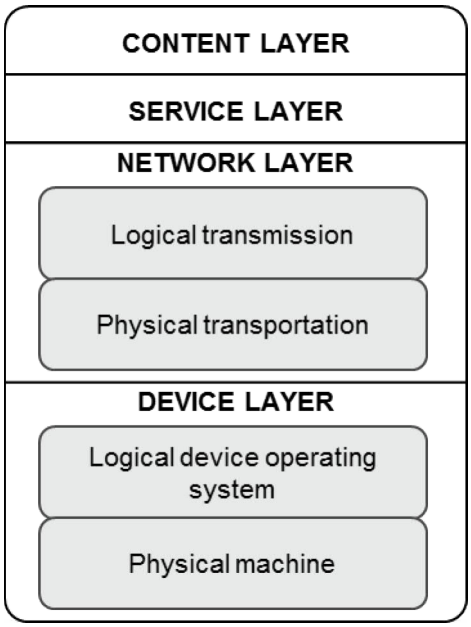

Figure 2.2: The layered architecture of digital technology (adapted from Yoo et al. 2010a p. 727).

The focus of the current research is to identify what content and services (i.e. digital services) the case company should offer to its customers and end users mobile devices and computers along equipment offering, which makes it essential to acknowledge the relation between digital service and the case company's physical equipment offering. Chowdhury (2015) identified from previous literature three main classes of product-related digital services when he studied digital service innovation in a heavy vehicle industry. The main classes are illustrated in Figure 2.3, in which the dependency of digital service to physical core offering increases from left to right.

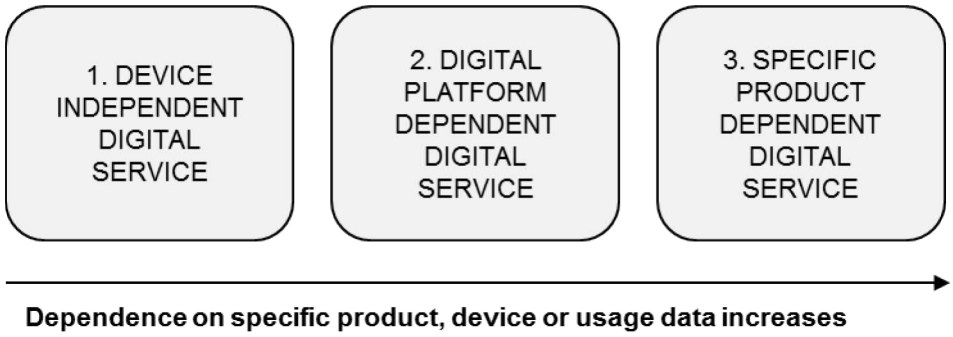

Figure 2.3: Main classes of digital services (adapted from Chowdhury 2015, p. 9).

The classes in Figure 2.3 are device independent digital services, digital platform dependent digital services and specific product dependent digital services. The first class of digital services is independent of specific product, which means they can be accessed typically via any internet enabled devices (Yoo et al. 2010a; Yoo et al. 2012; Chowdhury 2015). Classic examples of these type of services are electronic commerce businesses, which sell and display various kinds of goods via their internet channel. The second class of digital services requires a physical device, which supports specific digital platform, such as application marketplaces for smartphones. The final class of digital services is product or device specific. Functionality, content, and usefulness of digital services in the third class are depended on usage and presence of specific product type and at very extreme of individual product instance.

Given the objectives of this research and the case company situation, the focus should be towards to specific product dependent digital services in the empirical part of this study. The key areas of digital technology are content and services the user interacts with, rather than the digital technology itself. Still, since the case company of this study is an industrial company, digital service in industrial context requires a deeper look. Therefore, next chapter reviews previous studies of industrial digital services to find state of the art of industrial digital service research.

2.2.3 Digital service in industrial offering

Research of industrial digital services today is primarily focusing on optimization of manufacturing companies service processes or to widen their service product portfolio. This development has created two research streams related to digital services in industrial offering: enhancing the efficiency of field service operations through mobile technologies (e.g. Herterich et al. 2016) and increasing service product portfolio by offering remote monitoring solutions and services (e.g. Brax & Jonsson 2009; Grubic & Peppard 2016). First deals with the optimization of internal service processes and following servitization strategies of manufacturing companies. These areas are overlapping both in literature and in practice – utilization of mobile technologies in technical customer service many times

requires digitized data and information gathered by remote monitoring solutions (Herterich et al. 2015b).

Remote services have received attention in academia, arguably due remote services are today fundamental part of manufacturing companies servitization strategy (Brax & Jonsson 2009; Grubic & Peppard 2016). Brax & Jonsson (2009) were pioneering this field when they conducted a descriptive, comparative case study of remote diagnostic service development in two manufacturing companies. They focused especially on case companies integrated solution offerings, and to the role of remote services in those integrated offerings. At the time Brax & Jonsson (2009) concluded, that both cases companies were at least partly failed to properly address their customer needs and preferences due to technical perspective to service provision. Grubic & Peppard (2016) conducted an in-depth multiple case study comprising four companies operating in aerospace, industrial equipment, marine, and transport sectors. They focused on identifying how remote monitoring technology is currently used to support servitization strategies by those manufacturing organizations and found insights how the technology enables and constrain execution of their strategies.

Research in technical customer service mobile applications is primarily focused on technical aspects of available technology and required information architectures. For example, Thomas et al. (2007) studied how mobile technologies can increase field service efficiency in German machine and plant construction industry. They focused on assessing how these wireless technologies could be utilized in technical customer service, especially by offering digital documentation and troubleshooting support. The focus of their research was to create information system architecture for digital service delivery. Fellmann et al. (2013) took a more user-centric approach in their constructive research, where they created digital service for supporting field service technicians' everyday tasks. They identified needed digital services by mapping specific use cases by observing service technicians work. However, the focus of the project was the creation of the information architecture.

Arguably the research stream which is focusing on to utilization of mobile technologies is closer to the nature of this study. The objective of this study is to identify those digital service opportunities, which the case company can deliver along with their equipment offering without adding digital technology to the machine itself, rather than opportunities to expand the case company's remote service portfolio. Given that customers, and users of the equipment, are assumed to own needed digital technology (i.e. mobile devices such as smartphones), it is possible to offer such services along the core offering without the need to install too many new capabilities to the equipment itself. Table 2.1 is summarizing findings from the researcher's literature review consisting six conference papers and two journal articles regarding actual use cases of industrial digital service.

Table 2.1: The reviewed literature of industrial digital service (summarized by the author).

Authors	Paper type	Research settings	Key content
Thomas et al. (2007)	Conference paper	German state-funded case study of machine and plant construction industry	Building information system fit for mobile applications used in machine and plant construction industry field service
Aleksy & Stieger (2010)	Conference paper	Partly German state-funded project conducted in ABB	Creation of mobile information system architecture based on technical customer service use cases
Fellmann et al. (2011)	Conference paper	German state-funded project for empowering technical field service operations in machinery industry	Creation of integrated information system architecture for supporting mobile applications used in technical customer service
Tesfay et al. (2013)	Conference paper	ABB funded research project	Creation and evaluation of augmented reality smartphone applications in use for technical field service
Fellmann et al. (2013)	Conference paper	Part of German Federal Ministry of Education and Research funded project	Development of service platform to facilitate technical field service everyday tasks in trucking industry
Herterich et al. (2016)	Journal article	In-depth multiple case study of ThyssenKrupp and Siemens	Identifies actions how companies can harness new service innovations by building data-driven industrial services
Legner et al. (2016)	Journal article	Single case study of mobile applications in automotive industry	Creation and evaluation of mobile applications for maintenance tasks
Niemöller et al. (2016)	Conference paper	Literature review and a single case study of smart glasses in intralogistics industry	Usefulness evaluation of wearable smart glasses in technical customer service

As can be seen from Table 2.1, there is already constructive, empirical research carried out, where the focus is to develop digital services for technical field service in machine industry. However, surprisingly there are no previous studies conducted, which concentrates on the development of user-centric digital services delivered along physical equipment. The extant literature related to the creation of industrial digital services, which utilize mobile technologies, provides only highly technical perspective to the field. Herterich et al. (2015a) came to the same conclusion when they conducted an extensive literature review about the current state of research regarding the use of mobile technologies in industrial field service.

First studies are combining the two research streams by taking a more holistic view and considering how remote monitoring could change industrial field service. Herterich et al. (2015c) studied how technical customer service can benefit from digital innovation in the machinery industry. Their research studied remote monitoring capabilities of three large machinery manufacturers, and by conducting an extensive round of workshops and interviews with representatives of these companies, they identified several clusters of opportunities that remote monitoring technologies can offer to mobile technical customer service workforce. These opportunities could be harnessed by utilizing data from installed base machinery and delivering information to service technicians mobile devices, which would support especially their knowledge-intensive tasks.

From a technical perspective, there is an opportunity to deliver at least some digital service designed to support knowledge-intensive tasks of own technical field service also to customer's service engineers and equipment operators. Still, as previous studies of digital services have been conducted based on use cases within a manufacturing company field service organization, current digital service studies are linked primarily to maintenance and service tasks. Arguably, opportunities to enhance operational mode of the core offering has not received attention in the previous literature.

To conclude, literature regarding industrial use cases of digital services is currently focusing on remote services and their role in fulfilling manufacturing companies servitization strategies and secondly enhancing OEM field service operations via digital services used on mobile devices. However, digital services delivered along core offering, which would enable new capabilities and benefits for the customer and users, has not been researched in industrial settings, which gives room for the current research to take a holistic approach to service innovation.

2.3 Competitiveness through service innovation

2.3.1 Competitiveness of integrated offerings

The case company is aiming to enhance the competitiveness of their equipment offering, which means perceived attractiveness by the customer over competing solutions for the

same need (Cooper 1994). Typically, differentiation or cost leadership are sources for a competitive advantage, which can provide a more compelling value proposition for the customers (Ulaga & Reinartz 2011). Existing literature presents multiple factors influencing on competitiveness and success of offerings containing both physical equipment and intangible service, which according to Ulaga & Reinartz (2011) are hybrid-offerings. Therefore, to assess if holistic perspective to service innovation is beneficial, the extant empirical literature of competitive advantages that hybrid-offering create requires a deeper look.

Existing literature assess the success of hybrid-offerings through differentiation, cost leadership, and customer satisfaction. Ulaga & Reinartz (2011) researched what resources manufacturing companies' need, so they can successfully combine services and physical products into a hybrid-offering. They used a multiple case study approach and interviewed in their exploratory research top-level executives from 22 manufacturing companies operating in various fields, and they considered that success criteria for creating hybrid- offering are differentiation and cost leadership over the competition. To assess how hybrid-offerings influence on manufacturing companies' customer's satisfaction, Raja et al. (2013) studied customers of a large international manufacturing company. The case company of their research offered industrial machinery and services, as well bundles of products and services as hybrid-offerings. Raja et al. (2013) found that relational dynamic (customer relationship) and access (service is available outside business hours) to be most important components of customer satisfaction. Other important aspects were knowledge (about the offering and understanding of customer processes), the range of product and service offerings, delivery, price, and locality.

Bustinza et al. (2015) conducted a research how servitization initiatives of manufacturing companies can lead to competitive advantage. They studied data collected in an international survey of manufacturing practices, where the whole sample consisted 370 industrial companies. Bustinza et al. (2015) selected a smaller sample consisting 102 companies, of which 52 were manufacturers of heavy machinery and 50 medical equipment. In the final sample, 43.5 percent of companies were providing services globally. They found that when companies are offering services along with their products, gaining a competitive advantage over the competition with increased service offering requires differentiation as well high customer satisfaction. Even though their focus was to identify competitive advantage through services, many of their case companies' offerings fulfill the description of hybrid-offerings by Ulaga & Reinartz (2011). For example, companies in their sample were offering performance-based contracts, which certainly encompasses tangible and intangible features. Table 2.2 summarizes main findings from the reviewed literature regarding the competitive advantage of offerings, which entail both services and physical products.

Table 2.2: Summary of research describing the competitive advantage of hybrid-offering.

Author	Settings	Key content	Key components of competitive advantage
Ulaga & Reinartz (2011)	Multiple case study consisting interviews of top-level executives from 22 manufacturing companies	Developed a resource–capability framework for creating hybrid-offerings successfully	Differentiation and cost leadership
Raja et al. (2013)	An exploratory study consisting four customer organizations of one international manufacturer	Found key dimensions, which influence to customer satisfaction when delivering hybrid-offerings	Customer satisfaction, which consists knowledge, access, relational dynamic, range of product and service offerings, delivery, price, and locality
Bustinza et al. (2015)	Research based on a survey of 102 international industrial companies	Insights how to gain competitive advantage with increased service offering	Customer satisfaction and differentiation

When evaluating if digital service can affect the competitiveness of the case company's equipment offering, it is needed to remember that competitive advantage provides an ability to create, and facilitate, more value for its customers, shareholders and a company itself (Cooper 1994). Therefore, companies enjoying competitive advantage should perform better than their competitors from a financial perspective, which has been studied by Eggert et al. (2015). They investigated financial results that companies developing product, service, and hybrid innovations in industrial context achieve. Interestingly, when manufacturing companies focus too much on service innovation activities alone, they are likely to report lower profitability. It seems that overemphasizing service innovation at the expense of the product innovation in manufacturing companies does not yield best possible results. However, they confirmed that innovating hybrid-offering has a significantly positive result on industrial companies' performance and financial output. Indeed, innovation efforts on hybrid-offerings lead to competitive advantage in an industrial context. Eggert et al. (2015) combined data from 348 German industrial companies' innovation behavior at the firm level from the year 2006 and compared the data to their financial performance. In their sample, largest groups of companies were metal and machinery industry (96 companies), manufacturing electrical equipment (56 companies) and finally medical instruments (28 companies). Based on the sample of studied companies, their results seem applicable for current research.

Indeed, hybrid-offerings can create a competitive advantage for an industrial company, which has previously focused on products and services separately. The competitive advantage that these types of offerings yield are related to differentiation, customer

satisfaction, and cost leadership, which will be used as reference point for identification of digital service opportunities worth to pursue in the empirical part of this research.

2.3.2 Value creation in service logic

The focus of this chapter is value creation along industrial equipment by service offerings to construct a foundation for assessing how digital services facilitate value creation. In general, value creation and customer value have been studied extensively by a number of authors. Traditionally value is defined as being derived from the benefits provided for the customer and sacrifices experienced by the supplier (Eggert & Ulaga 2002). Later value creation has been realized to be constantly more interlinked, and complex phenomena across a wide variety of actors as manufacturing companies servitization continue towards remote services and their service offerings are shifting towards digital business (Barrett et al. 2015).

Intangible service offering should be designed carefully to support customer's processes. Grönroos & Helle (2012) found that once operational processes for traditional service delivery and customer's processes support each other's, the relationship is more likely to lead in a win-win situation between the two parties. Digital services are not an exception – for example, if companies offering remote services fail to address customer needs comprehensively customers do not perceive the offering valuable (Brax & Jonsson 2009). Therefore, when creating digital services, emphasis should be put on achieving sufficient understanding regarding customer's processes and practices.

Opportunities for value creation facilitated by industrial digital service requires not only supplier and customer but also surrounding systems and resources. As companies started to shift their focus towards service business, scholars have acknowledged that value is co-created together by the service offeror and the beneficiary (Lusch & Webster 2011). Jaakkola & Hakanen (2013) researched value co-creation in two solution networks to find how value is how co-created by a set of actors. Industrial solution network consisted three supplier companies, where one was integrating actor. They found that in a solution network the integrating actor indeed gets access to complementary resources, which are needed to satisfy customer need at a broader level. This same principle applies to digital services – utilization of digital technology automatically connects the service offeror to a set of actors, which resources are needed to service delivery.

Lusch & Nambisan (2015) conceptualized a value-creation framework for service dominant logic in the digital age, which encompasses a service ecosystem, service platform, and value co-creation. They define service ecosystem being a community of interacting actors, such as organizations, individuals, customers, and suppliers, where the overall effectiveness depends on others. Service platform is a modular structure combining resources, which can be either tangible or intangible. Considering this research, service platform is understood primarily as an industrial offering and resource liquefaction

means taking, or releasing, data and information away from its related physical place and arrangement, which means especially digitization of previously analogical information (Lusch & Nambisan 2015). The main function of service platform is to leverage resource density, and therefore allow fluent service exchanges among actors. Mobilization of resources, such as relevant information, effectively and efficiently, is defined as resource density. Finally, value-cocreation means integration of actors' resources in the service platform.

Previous studies of value created in use are focusing on traditional service activities, and therefore only the foundational insights apply to digital services. The digital service offering should support customer's processes and practices, and the complete offering should be aimed to address wider need than its components (i.e. digital service and physical offering) offered separately can fulfill. Therefore, customer's processes along equipment lifecycle call for a deeper look, which is the topic of next chapter.

2.3.3 Customer activities along equipment lifecycle

Existing scientific literature of digital services covers only operational and maintenance lifecycle phases of industrial equipment, which is why to identify digital service opportunities for the case company's industrial equipment thoroughly, it is needed to review what customer's main activities are in other lifecycle phases. An industrial equipment lifecycle in seen to begin from conceptual design and end in the disposal. Also, the equipment lifecycle would have two primary phases which are acquisition and utilization (Blanchard et al. 1990). Also, typically ownership of the equipment changes in between main phases inside the organization which is acquiring the asset (i.e. equipment) (Schuman & Brent 2005, p. 567). For example, when Schuman & Brent (2005) studied ways to improve asset management in the process industry, they summarized that research and development, or similar technical department, has ownership and responsibility for the acquisition phase, while operations department takes care of the utilization phase. Figure 2.4 present traditional, asset-centric view, of an equipment lifecycle.

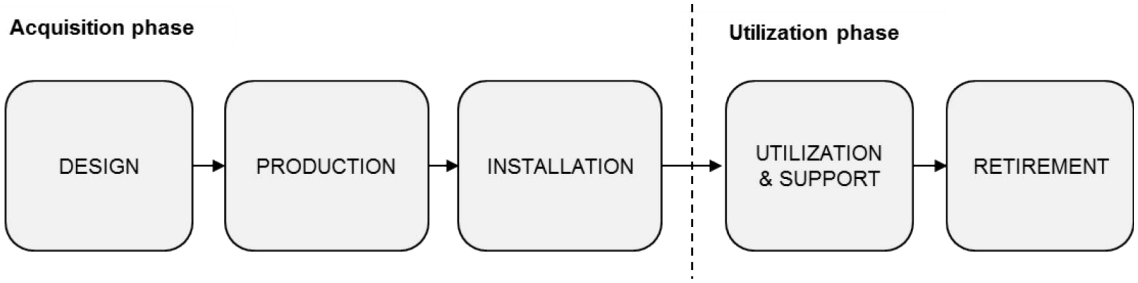

Figure 2.4: Asset-centric equipment lifecycle (adapted from Blanchard et al. 1990).

The acquisition phase entails design, manufacturing, and installation. Further utilization phase consists operation, maintenance as well retirement and disposal. However, this asset-centric view to an equipment lifecycle has been criticized for lack many critical

phases for the operator of an asset (i.e. the customer of an industrial company) (e.g. Aurich et al. 2007). Therefore, Hastings (2010) has pioneered the physical asset management literature by developing a process-centric view to equipment lifecycle, which provides a more detailed view to important decisions along the equipment lifecycle, which Figure 2.5 presents.

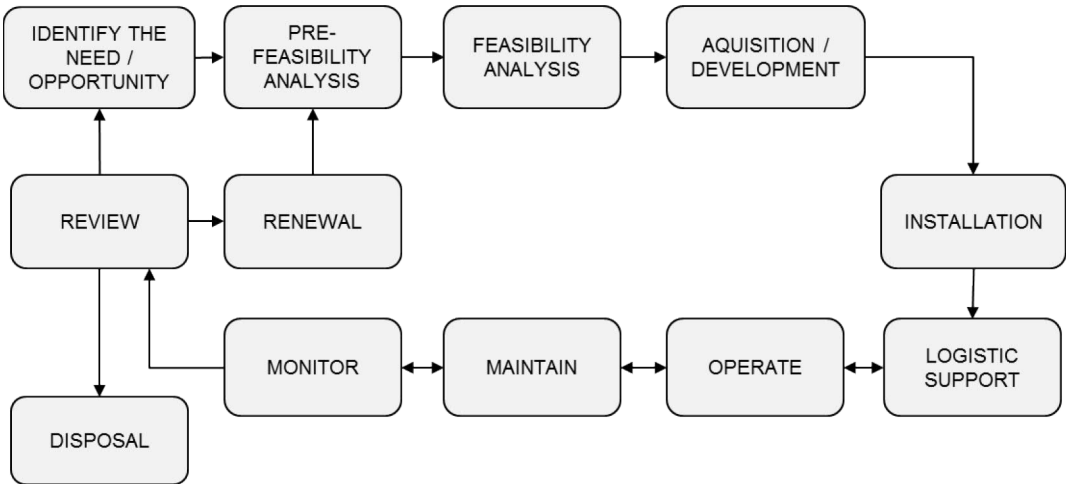

Figure 2.5: Process-centric asset lifecycle (adapted from Hastings 2010, p. 6).

Process-centric approach illustrated in Figure 2.5 to equipment lifecycle provides a framework for all relevant decisions, and phases equipment's operator goes through during an industrial equipment lifecycle. The lifecycle begins either from reviewing an existing business or from identification of a business need. Similarly to asset-centric model by Blanchard et al. (1990), the process-centric lifecycle ends to disposal and retirement of the equipment.

After *identifying of an opportunity* the operator typically performs *capability gap- and requirement analysis,* which means identifying the performance distance between required, and current capability. Further on, *pre-feasibility analysis* finds possible solutions to deliver needed capability defined in the previous phase. *Feasibility analysis* consists the costing and detailed analysis of preferred options, which act as a proposal for acquisition of industrial equipment or forming an agreement for delivery of some outcome by a service provider. *The acquisition, or development project*, is final approval of for example modernization project or purchasing decision. After the equipment installation, the *operational phase* begins. In addition to operation, physical equipment typically requires *logistics support* (for example spare part logistics) and *maintenance*. *Monitor and review* phase entails a technical assessment of equipment condition and facilitates the decision to either *dispose and replace* or *develop* the asset to meet current business needs. (Hastings 2010, p. 6) The process-centric equipment lifecycle provides the needed lifecycle orientation for the innovation process of digital services, which front end phases the next chapter reviews further.

2.4 Front end of service innovation

2.4.1 Front end of innovation

The empirical part of this thesis studies the heart of the front end of digital service innovation since the front end of innovation begins with the identification of an opportunity and ends when formal development project begins, or the concept is evaluated to be unfeasible (e.g. Koen et al. 2001). It is widely accepted both in academia and in practice that front end of innovation has a significant effect on overall performance of innovation process, and the overall performance of a firm (e.g. Koen et al. 2001; Alam & Perry 2002; Martinsuo & Poskela 2011). High uncertainty and many times "fuzzy" front end have drawn academic attention due to the strategic importance of the topic. The phases which happens before the development project presents one of the best opportunities to affect the success of the whole innovation process (Koen et al. 2001).

Multiple conceptualizations exist to describe the front end of innovation phases. Koen et al. (2001) highlight that key front end phases of product innovation are opportunity identification, opportunity analysis, idea generation, idea screening and idea concept development. Alam & Perry (2002) lists as the main front end of service innovation identification of an opportunity, idea creation, idea evaluation, and concept development. Depending on author the amount and exact content of these partly overlapping and iterative steps vary, but it is safe to say that first phase is identifying a problem or an opportunity which could be solved, and then further refining and formulating it before idea generation (Frishammar et al. 2016). After this, uncertainties are reduced by screening ideas and then conceptualizing the most promising ones.

The front end of innovation phases of radical concept creation is interesting for current research from existing innovation literature. Frishammar et al. (2016) conducted an inductive case study to identify differences and joining patterns behind the creation of novel ideas and radical concepts at Prime Group. They selected Prime Group as their case (operates in public relations, communication, strategy and business intelligence consulting and has been multiple times awarded for the creation of radical concepts, headquartered in Stockholm, Sweden) due to its successful track record with developing novel ideas and radical concepts. They followed and analyzed seven projects, where Prime Group had developed services, products, and offerings for large companies operating furniture industry, electrical appliances, government agencies, hotel services and packaging services. Even though Frishammar et al. (2016) research settings are not identical to empirical settings of this research, the settings are close enough. Therefore, their findings are used as a guideline when identifying the front end of digital service innovation in the case company. Figure 2.6 presents how Prime Group creates radical concepts, without classifying if the created offering is a service, a physical product or a combination of those.

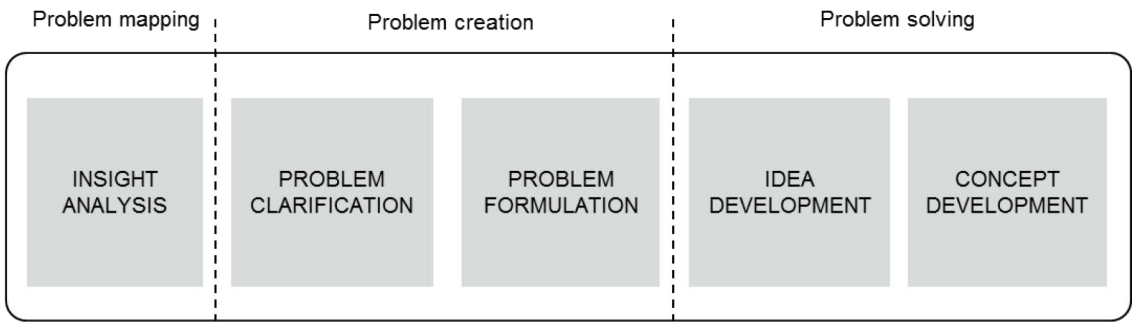

Figure 2.6: Main phases of the radical idea and concept development at Prime Group (adapted from Frishammar et al. 2016, p. 191).

Three identified main phases are problem mapping, problem creation, and problem-solving (Frishammar et al. 2016 p. 186). These major steps consist six individual and somewhat overlapping steps which are insight analysis, problem finding and framing, problem formulation, idea and concept creation, idea and concept refinement and concept development. As can be seen from the Figure 2.6, customer problem orientation is crucial when a consultative company such as Prime Group is developing concepts for their customers, which indicates that business problems of the case company should drive the empirical part of this study. To conclude, it is critical to understand the problem to be solved and have solid knowledge of the customer and end-user needs in the front end of innovation phases when creating novel and radical service concepts.

2.4.2 Service idea concept creation

The case company of this research has been driving their service concept creation process towards design thinking methodology for past couple of years, which is not surprising as design thinking in the managerial world has already years been titled as the best way to be innovative (Johansson-Sköldberg et al. 2013). Johansson-Sköldberg et al. (2013) examined the evolution of design thinking by reviewing the past and current scientific and managerial literature and found that the managerial body of literature originates mainly from design practice (from leading design companies such as IDEO). Design thinking in this research means a practical approach to arrange front end activities to create digital service concepts based on user needs.

In design thinking approach user and customer influence is emphasized (Liedtka 2015), and indeed, user and customer involvement has been studied to play a significant role in service innovation. Alam (2002) pioneered research of user involvement by conducting a multiple case study of Australian financial service organizations. He found that front end activities of new service development are more streamlined if customers are involved and later he confirmed that customer involvement makes the overall new service development process outcome more successful (Alam 2006). Table 2.3 presents models of design thinking process used in practice which Liedtka (2015) summarized.

Table 2.3: Practical models of design thinking process (adapted from Liedtka 2015 p. 928).

Phase	IDEO	Continuum	Stanford Design School	Rotman Business School
1. data gathering about user needs	Discovery and interpretation	Discover deep insights	Emphasize and define	Empathy
2. idea generation	Ideation	Create	Ideation	Ideation
3. testing	Experimentation and evolution	Make it real: prototype, test and deploy	Prototype and test	Prototype and experiment

The main phases in design thinking process are data gathering about user needs, various methods for idea generation and finally concept testing (Liedtka 2015 p. 928). The exact methodologies of these phases vary depending on context, but the overall process seems to resemble the process identified by Frishammar et al. (2016) in Prime Group. However, the case company of this study is still on its journey to adopt design thinking practices, and it is not possible to start ideation of digital services from end-user observations.

Aurich et al. (2007) developed a framework to systematically ideate service offering to support customer's processes. They found that to ideate technical services, it is necessary to adopt customers' point of view of the equipment lifecycle. They developed and tested their framework when working with a medium sized industrial company, which was developing and manufacturing heavy road construction machines as well offering services. The reliability of their results is reduced as their research consisted only one case, but their methodology can give direction to present research. After all, the case company Aurich et al. (2007) studied offered services and machinery in B2B context for the relatively similar type of customer segment as the case company of this research. Figure 2.7 presents the matrix for systematic customer-oriented service ideation.

		Customer lifecycle		
		Purchasing	Usage	Disposal
Service ideas	Product oriented		*Maintenance*	
	User oriented	*User Training*		
	Process oriented		*Optimization*	
	Logistical			*Take-back*
	Information and data		*Telematics*	
	Financial	*Rental*		

Figure 2.7: Customer-oriented service ideation matrix (Aurich et al. 2007 p. 174).

Aurich et al. (2007) suggest that ideation begins by defining the physical core product itself, which gives the context for ideation as well the target customer. Then, services are ideated along the lifecycle of the core product from customer's perspective while on the vertical axel are different service types. As can be seen from Figure 2.7, the ideation framework by Aurich et al. (2007) is indeed customer oriented from the lifecycle perspective, but it fails to incorporate the actual user of the offering to the ideation process.

To conclude, even though the scientific literature of design thinking is still evolving, the approach can guide and explain service idea concept creation in the empirical part of this research. Since the overall front end of service innovation should be driven by customer and user insights and problems (e.g. Alam & Perry 2002; Alam 2006; Frishammar et al. 2016), the service ideation framework can only provide a starting point for ideation.

2.4.3 Using customer and user insights

Purpose of this chapter is to introduce the most important notes from the previous literature regarding how to use customer and user insights in the front end of service innovation. Also, the chapter takes into account the characteristics which use of digital technology for service delivery creates. Role of customers and users shifts when developing digital innovations (Abrell et al. 2016). Customer and user insights in digital innovation have been studied in industrial context only by Abrell et al. (2016), which indicates that the research area is highly novel.

When industrial manufacturing companies create digital innovations, firms need to adopt new methods and practices to use and acquire customer and user insights to concept creation. Abrell et al. (2016) conducted a multiple case study consisting three companies manufacturing heavy machinery to assess, how to use customer and user knowledge for digital innovation in an industrial context. Case companies Abrell et al. (2016) studied have similar offerings and customer segment as the case company of this research – they manufacture complex technical solutions and offer services to their customers. The first company produced marine products, second automation and systems technologies and third plant and component technologies. Given that Abrell et al. (2016) selection of cases resembles the case company of this research, their findings can be considered highly relevant for this study. Also, their case companies are concerned to be ongoing diffusion of digital technologies in their industries, which even further brings their study closer to current research. Table 2.4 summarizes reviewed methods to gain customer and user knowledge for digital innovation from existing literature.

Table 2.4: Practices related to the customer- and user knowledge (modified from Abrell et al. (2016)).

Authors	Source	Practice	Description	Purpose	Type
Abrell et al. (2016)	Customers	Feedback meetings	Project meeting with customers to estimate progress and approve the direction	Gathering feedback and ideas from customers regarding works in progress	More explicit
		Sales meetings	Constant discussions with customers to maintain offering with their changing needs	Learning about new product requirements and problems with the existing offering	More explicit
		Management meetings	Regular meetings with important customers' management	Understanding the customer's vision, strategy, and long-term goals	More explicit
	Users	Use of front-line employees	Using maintenance and field service workers as knowledge sources; hiring R&D employees with user backgrounds	Understanding shop floor processes and the usability of current products without involving the users themselves	More tacit
		On-site user studies	Visiting users at their workplaces; interviewing and observing the users	Empathizing with users; identifying latent user needs; understanding work context and work practices	More tacit
		Prototyping	Demonstrating new concepts with tangible prototypes	Demonstrating and discussing novel products and features	More tacit
Woisetschlger et al. (2016)	Customers	Use of front-line employees	Using frontline employees to idea fishing	Gathering new ideas from customer in customer contact situations	More explicit
Liedtka (2015)	Users	On-site user studies	Observing users and interaction with them in research of innovation opportunities	Understand user's latent needs by empathizing and observing them	More tacit
		Prototyping	Facilitate making abstract ideas tangible	Aim to enhance the accuracy of feedback conversations	More tacit
		Co-creation	Engage users in generating, developing, and testing new ideas	Used throughout the process to remain user-centric	More tacit
		Field experiments	Feld testing the identified assumptions using prototypes	Test the key underlying and value-generating assumptions	More tacit

Acquiring customer knowledge is relatively straightforward for industrial B2B companies (Abrell et al. 2016; Woisetschlger et al. 2016). Customers are many times able to express their current needs and problems (Woisetschlger et al. 2016), but this source of knowledge and ideas leads to somewhat incremental innovations (Slater & Narver 1998). Insights are mostly gathered in meetings at different levels of representatives at customer organization. Customers' decision makers typically make purchasing decisions based on short-term business projections, and they typically fail to express their latent needs which digital services could fulfill.

The actual users of industrial equipment can show long-term visions for digital innovation and be a great source of tacit knowledge (i.e. latent needs) (Abrell et al. 2016, p. 329). However, acquiring user knowledge creates major challenges for industrial B2B companies. Difficulties arise from contacting and finding the right users, who adopt new technologies first and can suggest and create novel and innovative ideas in early phases of the overall innovation process. Indeed, the empirical part of this research has to address the difference between customers and users of equipment.

Using digital technology to facilitate innovation processes themselves have received a considerable amount of academic attention (e.g. Sandstrom & Bjork 2010; Deichmann & Ende 2013). Today, many large organizations are utilizing internet-based systems to support the organization-wide search of customer and user problems and solutions (i.e. new ideas). These IMSs allow companies' employees to submit ideas, as well refine and develop ideas submitted by other employees. Woisetschlger et al. (2016) studied why frontline employees work as idea collector in a variety of industrial and business services firms. They found that to use ideas, which frontline employees collect in customer contact situations, the ideas need to be spread to companies' other employees. Otherwise, companies lose those innovation opportunities. Since the case company of this research has an active idea platform in use, the choice to utilize it in empirical section of this study seems viable. Still, it is relatively unknown, how manufacturing companies' innovation processes should adapt and be organized to be able to create and identify concepts worth to pursue.

2.4.4 Opportunity identification

Idea concepts created in the front end of innovation generate strategic opportunities for companies. Indeed, the core element of this study's empirical part is identifying opportunities that digital service idea concepts create for the case company, which is why the topic requires a closer look. Overall, the essence of opportunity identification is sources and methods a company uses to identify innovation opportunities (Koen et al. 2001), which makes the practice very case sensitive.

Strategic opportunities in the front end of innovation are evaluated concepts, which have potential to serve companies current and future customers and enhance companies' profitability. In more details, Martinsuo & Poskela (2011) described strategic opportunities in product innovation context through "competitive potential and future business potential," which evaluated concepts create in the front end of innovation. The competitive potential of a concept in the front end of innovation is the evaluated competitive advantage, what the concept would create in the marketplace. The future business potential is the evaluated competitive potential that a concept can create for a company in future.

Sources for successful service concepts (i.e. concepts which create strategic opportunities) are rooted to the user- and customer needs and problems (e.g. Alam 2006). A systematical search of innovation opportunities is then identifying and selecting right and valuable customer- and business problems to be solved (Frishammar et al. 2016), which is a challenging task in practice. Frishammar et al. (2016) conclude that the challenges emerge from assessing, which problems are valuable enough to find a solution. They further add, that problems often consist sub-problems and symptoms, which create many pitfalls. Companies might realize problem too narrowly or simply formulate and adopt the wrong problem to be solved. As findings from multiple case study of financial services firms conducted by Alam (2006) shows, practitioners and researchers have been tackling this issue over a decade by involving customers and users to already front end phases of service development.

Customer and user needs can be either latent or expressed (Slater & Narver 1998). Expressed needs are those which customers and users of the companies' offerings are aware of having and therefore can articulate clearly. Fulfilling these needs can be a great source of innovation opportunities, however typically concepts based on expressed needs are not as novel nor radical compared to those based on latent needs (Slater & Narver 1998, p. 1002). Latent needs are those, which customers and users do not realize, which is why are also difficult to express. Concepts based on fulfilling latent needs are typically more novel and radical, but identifying those needs and creating concepts to fulfill them is challenging task in practice, which is why multiple approaches and methodologies exist to discover latent needs. Existing literature suggests that companies should proactively test their concepts and prototypes with customers and users, as well observe companies' offerings in a real environment with end users (e.g. Slater & Narver 1998, p. 1003; Liedtka 2015). This way companies can acquire information about customer needs, which are out of reach of traditional methods, such as questionnaires or focus groups.

Even though identification and evaluation of identified strategic opportunities has a significant effect on the overall innovation process, the topic has not been studied much in scientific literature. Evaluation of service idea concepts is indeed such an important area for opportunity identification of industrial digital services that it is the topic of the final theoretical chapter.

2.4.5 Service idea concept evaluation

Evaluation of ideas and concepts is required in this research to select which ideas will be conceptualized and to create a suggested roadmap for digital service development. All innovation processes include some screening and evaluation of ideas. In idea generation phase, a lot of ideas and opportunities arises, and companies aim to select best ones to development by formulating and evaluating the created ideas (Koen et al. 2001). Ideally, idea selection and screening process aim to identify the most promising idea concepts and select them for testing or development. By evaluating ideas companies aim to compare the business potential of the opportunity the ideas can yield (Martinsuo & Poskela 2011), as well to make sure the ideas solve the problem that they intend to (Frishammar et al. 2016).

Martinsuo & Poskela (2011) studied how the use of evaluation criteria in the front end of product innovation affects the companies' innovation performance. Based on questionnaire survey responses from 107 Finnish medium and large industrial manufacturing companies R&D directors (or their representative product development managers and experts), they found that practitioners use evaluation criteria in diverse ways with the two different descriptions of strategic opportunity (i.e. competitive potential and future business potential). Use of the assessment criteria to evaluate ideas and concepts was less relevant to the customer- and a competitiveness-centered measure of competitive potential and had more relevance to the market- and a capability-centered measure of future business potential (Martinsuo & Poskela 2011, 906 – 907). Still, if a company employees do the evaluation of concepts, it is hard to anticipate the perceived attractiveness of the solution from the eyes of customers (Woodruff 1997).

The first step in idea screening process is to determinate the criteria which will be used to evaluate the ideas (e.g. Wheelwright & Clark 1992). Traditionally idea screening is conducted by employing a rational evaluation process to compare ideas with the help of specific criteria. The overall screening process is many times demonstrated as a funnel, where all the ideas go through a number of filters and gates, and only a small number goes to market. Service innovation literature suggests emphasizing customer insights and interactions throughout this process (e.g. Alam 2006). Feldmann & Kohler (2015) summarized key factors for service idea assessment in the front end of service innovation:

1. Criteria, which shows what should be assessed
2. Information sources, to tell which input should be considered
3. The group who should conduct the idea assessment
4. Assessment perspective to tell what mindset and timeline should be applied
5. Approach, how service idea assessment is organized

From the key cornerstones, only idea evaluation criteria is somewhat open in empirical part of the research, which some scholars have studied in both services- as well in product

innovation literature. For example, Magnusson (2009) studied how ordinary users can contribute to ideation of new technology-based services in the telecom industry. To compare the ideas created by users and experts, they used a focus group of five professional from Telia Mobile in the selection process of employed evaluation criteria. The selection criteria for selected dimensions were factors that "differentiate successful mobile telephony services from less successful services." Differentiation in the eyes of the customer is a source of competitive advantage (Cooper 1994), which means that the selected evaluation criteria were to assess more competitive potential of the ideas (Martinsuo & Poskela 2011). The used criteria were originality (i.e. innovativeness and novelty of the idea), user value (i.e. if the service idea can create value for the customer) and producibility (i.e. feasibility to realize the idea). Later, Magnusson et al. (2014) conducted a research where experts had to evaluate 83 ideas. The case company of their research was a large telecom operator, and they used ideas originated from the company's customers. The objective of the study was to compare two popular idea assessment techniques to further understand the especially intuitive evaluation of new product and service ideas. In their study, four of experts from the case company evaluated the set of ideas in two different manners. Magnusson et al. (2014) found that the experts used five criteria in their decision-making; originality, user value, producibility, strategic fit, and profitability. They concluded that when intuition plays a great role in idea evaluation, the experience of the person conducting the assessment in the specific context is needed. Table 2.5 summarizes reviewed evaluation criteria found from previous empirical literature.

Table 2.5: Reviewed evaluation criteria of ideas in earlier research.

Authors	**Criteria**
Carbonell-Foulquié et al. (2004)	Strategic fit, technical feasibility, customer acceptance, market opportunity, financial performance
Magnusson (2009)	Originality, user value, producibility
Kudrowitz & Wallace (2013)	Novelty, useful, clear, product worthiness
Magnusson et al. (2014)	Originality, user value, producibility, strategic fit, profitability

As such, the evaluation of ideas against certain criteria does not yet give too much content to the actual decision-making practices in the front end of innovation. Also, the relationship between use of evaluation criteria and innovation performance has been studied only in product innovation context by Martinsuo & Poskela (2011). Based on previous findings regarding the evaluation of ideas and concepts in the front end of product innovation, it seems that idea evaluation criteria do not need strict formality due to customer orientation of desired concepts (Martinsuo & Poskela 2011). The people conducting the assessment have the high expertise of the context, which suggests allowing some level

use of intuition (Magnusson et al. 2014). Customer- and user orientation should be applied to assess how well idea concepts can solve their latent- and expressed needs (Slater & Narver 1998).

To conclude, existing scientific literature directs to use evaluation criteria together with expert intuition for idea assessment and selection. However, since the selection of evaluation criteria is highly context sensitive and there is no existing empirical literature conducted in similar settings as current research, the empirical section of this study should formulate evaluation criteria for digital service idea concept assessment with the case company experts.

2.5 Synthesis of theoretical part

Purpose of this chapter is to synthesize the most relevant extant knowledge from scientific literature related to opportunity identification for industrial digital services. The research topic requires understanding the opportunities that utilization of digital technology allows and the process how digital service innovations are created. Opportunity identification for digital technology-based services can be summarized as creating and evaluating concepts, which solve expressed and latent customer- and user needs by utilizing digital technology for service delivery.

It is necessary to have digital service idea concepts before the opportunities can be identified, which means that ideation phase is crucial. The service ideation matrix that Aurich et al. (2007) created for PSS ideation can serve a starting point for digital service idea generation in empirical section of this study since the case company has already defined the core physical product. However, based on Abbrell et al. (2016) findings, the user-centric viewpoint is critical to successfully create digital innovations (including digital service innovations) in an industrial context. Design thinking methodology also supports user-centricity, where the starting point for concept creation are user observations (Liedtka 2015). It is therefore needed to include digital service user to the ideation matrix, which Abrell et al. (2016) found to be equipment user and customer.

Next, to make sure that customer processes are taken into consideration, the framework is also modified to be more accurate by utilizing process-centric equipment lifecycle defined by Hastings (2010). Manufacturing companies, which offerings contain both physical- and intangible features, achieve higher profitability, and therefore their innovation processes and efforts lead to better results (Eggert et al. 2015) when the intangible service offering matches to customer organization processes and practices (Grönroos & Helle 2012). If digital service ideation begins from the case company's perspective, it very well might not solve any customer nor user's problems and therefore has little impact on the competitiveness of an industrial offering. Figure 2.8. presents simplified initial ideation framework constructed from existing literature.

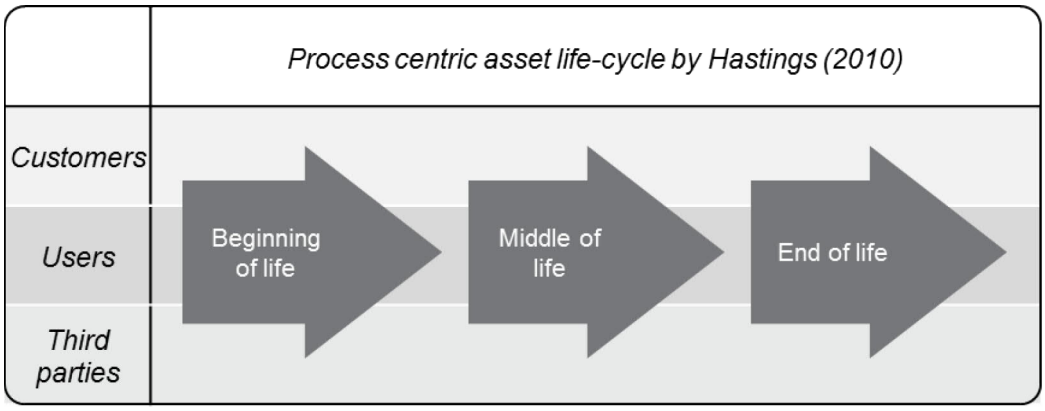

Figure 2.8: Initial ideation framework (with simplified equipment lifecycle).

Existing literature suggests that evaluation is the next key aspect after the creation of digital service idea concepts. The assessment should be based on both formal and holistic criteria, as well expert's intuition. Based on Lerch & Gotsch (2015) findings digital service idea concepts should have high strategical fit, since offering pure digital services seems to be next logical step for the case company, which is already offering ICT -based digital services. Also, digital service idea concepts should be at least somewhat dependent on the related core physical device. Otherwise, differentiative benefits of digital service to the physical core offering might leave unclear.

Previous studies also suggest including customers and users in the front end of service innovation phases, which should streamline service idea evaluation and selection process (Alam 2006). However, since industrial customers and users typically fail to express their potential needs for digital innovation, the case company must proactively offer customers and users see and test prototypes (Abrell et al. 2016). To gather customer and user knowledge to ideation and evaluation it is possible to utilize the case company's IMSs, frontline employees and a diverse team in front end phases of innovation process (Sandstrom & Bjork 2010; Deichmann & Ende 2013; Liedtka 2015; Woisetschlger et al. 2016).

Still, current literature does not provide a way for identifying industrial digital service opportunities. Therefore, more understanding is needed how to create and identify digital service opportunities, which enhance the competitiveness of the case company's equipment offering. It is a needed to address in the empirical part of this study that how to organize the front end of digital service innovation and how to create digital service idea concepts. Also, the existing body of knowledge does not explain what user-centric digital services are, and what kind of strategic opportunities they create. By utilizing the case company, empirical part of this research is aiming to contribute to the scientific literature by addressing this research gap.

3. RESEARCH METHODOLOGY

This chapter introduces selected research methods as well data gathering and data analysis techniques used in the empirical part of this thesis. The chapter begins by describing the case company and later a particular emphasis is put to introduce, describe and report the research settings.

3.1 Case description

The case company of this research is a large global industrial company, which manufactures industrial equipment and offers lifecycle services, such as maintenance, repair, overhaul and additional services for industrial machinery. Roughly 80% of current service base is not manufactured by the case company, and therefore own installed base account only a part of the service base. The case company's global service base consists hundreds of thousands of pieces of equipment, which are under service contracts.

The case company consists three separate business areas, which each represent roughly third of the case company's annual revenue. Multiple support functions support the three business areas. The case company itself has over 17 000 employees, and its annual revenue is more than three billion euros. Figure 3.1 presents rough organizational structure of the case company.

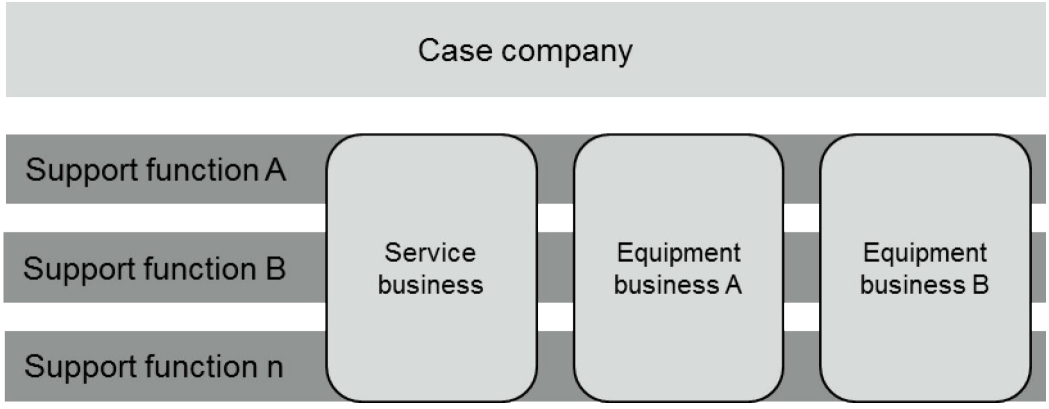

Figure 3.1: Organizational structure of the case company.

Figure 3.1 presents the organizational structure in an elementary form. This thesis was conducted in support function A, which is responsible for the case company's competitiveness from a technological point of view. As the case company has separate areas for service and equipment business, the support function working together with all business areas was a natural to place to carry out this research. The empirical examination of this study observed cooperation between support function A (technology development), service business and equipment business A. Annual volume of sold products by equipment

business A are in tens of thousands of units. The case company sells multiple types of products, and this study focused on a single product platform.

The case company is seeking digital services to be a differentiative factor in new equipment sales by creating non-tangible value propositions, such as "world's most fluent spare part purchasing" or "easiest access to owner's manuals." At the same time the case company sees digital services as an opportunity to be present in customer's life the whole equipment lifecycle, regardless if the customer chooses to carry out needed service actions for the equipment by themselves or outsource service activities to another third-party service provider. Even if the customer chooses to outsource service and the case company would not get the service contract, the case company would still be present in customer's life with its digital services. The case company assumes that digital service would lower the bar for the customer to contact the case company and purchase services or even outsource service activities solely to the case company. This way the case company is also trying to increase its service business from its installed base.

Creation of digital services has been difficult in the past for the case company, due to technological limitations as well difficulties in aligning incentives between organizations different business areas. Increasing competitive pressure has aligned the business areas views, and all parties agree, that digital services bundled to new equipment offering will ensure sustainable business in future. Currently, the case company has digital service offering consisting remote monitoring solution, electronic commerce (e-commerce) channel, and internet-based customer portal, but up to the day, they do not offer any digital services along with equipment to ease equipment user's everyday tasks. Also, the case company utilizes a variety of digital tools to enhance their technical customer service efficiency.

3.2 Research methods

The empirical part of this research was carried out using multi-method research approach. From all possible methods and techniques to carry out case studies (Gummesson 2000), examining documented information, observations and semi-structured interviews were chosen to be employed. The empirical phase of this study consists data gathering from almost all front end of innovation phases, which makes the empirical environment of this study to change along the data collection. Therefore, it is needed to gain a broad perspective in the empirical examination, which is possible by combining methods (Hirsijärvi & Hurme 2008). Also, Hurme & Hirsijärvi (2008) notes that it is possible to enhance reliability of research by utilizing more than a single method. The multi-method approach also gives an opportunity to triangulate the findings to improve the validity of the study (Creswell 2013, p. 201). The chosen three methods allow the researcher to utilize the best fit for given empirical phase of the empirical research, which execution is elaborated further next. Table 3.1 displays research method for related empirical settings.

Table 3.1: Descriptive summary of used research methods and data sources.

Data source	Number of in-stances	Quantity / length	Research method
Idea management system	1	113 ideas	Review of documented information
Workshops	2	8 and 4 hours	Observation
Benchmarking interview	5	30 minutes each	Semi-structured interview
Result presentations	6	Between one to two hours	Semi-structured interview

First, the researcher examined ideas in case company's IMS and ideas created in workshops by reviewing documented information. The ideas are written to the IMS by the case company employees without much structure, which required that the researcher read the selected ideas, interpreted their core meaning and reflected them to existing empirical literature. Ideas, which participants created in the workshop were in more consistent form and therefore relatively straightforward to analyze. For data collection from workshop settings themselves, a natural choice was to use observations as the primary method. By observing the workshop, the researcher could gain close insights of the innovation process in the case company without interfering too much to the actual situation. As the researcher had been working in the case company for ten months before the workshops, nearly all the participants who were invited to workshops already knew him. Therefore, the participants were comfortable having the research around, and the presence or note taking of the author did not affect the course of how, and by who, decisions were made nor to the used arguments. The researcher gathered notes from two workshops as well from planning and preparation meetings. Observations were used to record decision-making criteria, persons making the decision and comments, which would tell how, and why the case company makes decisions. The researcher also had access to the e-mail communication during the whole research, which offered another valuable source of information. Finally, semi-structured interviews were used first to benchmark the created digital service idea concepts and then to find how the decision makers of the relevant business units in the case company perceive the created concepts.

While conducting the study, the chosen role for researcher was to be an involved researcher. In interpretive case studies the researcher can also be an outside observer, but because many times an action researcher gets an inside view to settings by being a member of the organization studied, the choice to be an involved researcher was simple (Myers 1997). In this role, the researchers usually can get access to both confidential and sensitive issues, which is essential to fulfilling the goals of this research. An extra effort is put to report how the research was carried out in Chapters 3.3 and 3.4, to shed light on what part the researcher has played during the empirical settings.

Theoretical basis in current research is used to inform the topics and approach of the earlier empirical works and to create an initial theoretical foundation for the empirical research. This choice was straightforward since according to Myers (1997) the role of theory in interpretive case study can be to create an initial theoretical framework, which takes account of previous knowledge. Next, the sequence of data collection and the method to be prioritized during data collection is elaborated further following suggestions for multi-method research (Creswell 2013).

The sequence of data collection was simple to decide. First, digital service ideas were retrieved only once from the case company's IMS at the beginning of the empirical part of this study, while preparing the workshops. Observations were carried out at the workshops and in the meetings along the innovation process to document the front end phases as accurately as possible for later analysis. The researcher analyzed further ideas, which participants created in the workshops. Finally, the researcher interviewed key people from the case company after each digital service concept presentation as well other industry experts in a trade show to benchmark of digital service idea concepts. This way, the interviews could be used to find out how the case company's decision maker interpreted the results of the front end of digital service innovation and to assess the novelty of created concepts with benchmarking.

The overall research question guided to prioritize observations, since this way it would be possible to report a possible repeatable framework for the case company, which can be used to continue the work to other product platforms. By focusing on semi-structured interviews, the researcher would be able to know in details how the decision-makers see the digital service concepts and study more the strategic opportunities. Focusing on interpreting the digital service ideas would provide greater depth to the digital service idea concept portfolio itself. Still, emphasizing observations provides more insights to the front end of innovation digital service innovation. Finally, all the results of this research are purely qualitative, even though from the used empirical data the retrieved ideas from the case company IMS might make possible to produce also quantitative results.

3.3 Data collection

The first empirical data source is the case company's IMS, which has been in use from 2011. Anybody working for the case company has access to the platform, can submit an idea and comment other's ideas. At the time of the review, the IMS had nearly 4 500 submitted ideas. During the meetings, the case company's innovation management team informed the researcher, that up today all ideas were relevant to consider at analysis since digital service ideas were developed only on a concept level and they might be a good source for customer and user insights as well for proactive digital service ideas.

The second data source is the series of digital service ideation workshops. The researcher participated in the preparation work for the workshops but stayed in the role of an observer during the workshops to have time for taking notes as well to have a more objective overall view to the workshops. Still, the data gathered has been influenced by the researcher's interpretations and therefore is somewhat subjective.

The third source of empirical data is a series of loosely structured interviews. The researcher together with the case company innovation manager interviewed representatives of companies manufacturing and offering services for industrial air compressors to benchmark the case company's digital service idea concepts. Benchmarking focuses on to identify best practices from outside a company and has been widely employed to find best new product development and innovation processes (e.g. Cooper & Kleinschmidt 1995; Cooper 1998). Therefore, benchmarking digital service idea concepts against what is currently on the market, was decided to be a suitable approach to assess them. Finally, theresearcher together with the innovation manager and the case company's business designer interviewed the case company's decision makers after presenting conceptualized digital service ideas to them. The researcher was not able to participate to one of the result presentations, which means that one instance of the case company interview data is secondary. Other data used in the research is primary and collected by the researcher.

3.3.1 Review of existing ideas

The case company's IMS has extensive search parameters, and the case company's innovation management team classifies all submitted ideas. The classification of ideas is made based on their type (software, electrical, mechanical, business) and key concept (usability, mechanical structure, core, measuring and monitoring, maintainability, service process, manufacturing process, organizational way of working, service tool, customer engagement, new concept or threat, new offering, business model, marketing and local initiative). Table 3.2 presents literations of the idea types and concepts used in the case company's IMS.

Table 3.2: Idea types and concepts in the case company's idea management system.

Idea type / concept	Description
Software	Software ideas are ideas which require some software know-how
Electrical	Electrical ideas change the electrical system of the equipment
Mechanical	Mechanical ideas are related to the physical structure
Business	Business ideas primary need business skills to understand customer needs driving the idea or the needed next steps to develop it further
Usability	"Usability" gathers user-driven ideas, i.e. how user uses our products, which are for example related to human-machine interface or facilitate better functionality of the equipment
Mechanical structure	"Mechanical structure" encompasses ideas related to load carrying structure. However, the category does not include ideas which are modifications of the structure more maintainable
Core components	"Core components" are ideas related critical mechanical components manufactured in-house by the case company
Measuring and monitoring	"Measuring & monitoring" category encompasses ideas which aim to enhance equipment measuring and monitoring capabilities
Maintainability	"Maintainability" includes all ideas, which intends to ease our maintenance processes by making changes to any product, feature or part in the case company's offering
Service process	"Service process" ideas aim to enhance the case company's existing service offerings
Manufacturing process	"Manufacturing process" ideas are close to local initiatives, which aim to make manufacturing processes smoother or more cost efficient
Organizational way of working	"Organizational way of working" gathers general ideas, which gives input how the case company's organizational processes could be done, or what new should be done
Service tool	"Service tool" concept gathers all ideas which are related (or are) tools for service technician
Customer engagement	"Customer engagement" means different ways to communicate with the case company's existing customers. Concept also encompasses ideas, which aim to enhance customer motivation to use their services and ideas related to software systems
New concept or threat	"New concepts or threats" are ideas, which can be viable business opportunities or threats, such as concepts that can disrupt the market and make existing offering not needed
New offering	"New offering" means ideas which are ready to be offered and require market testing and analysis and do not fundamentally change the case company's existing business
Business model	"Business model" ideas tell how and to whom value is delivered, and why this is creating income, as well new offerings, which require fundamental change to the case company's existing business model
Marketing	"Marketing" encompasses ideas that are related to the case company's brand visibility and other initiatives that aim to bring the case company to wider audience
Local initiative	"Local initiative" category encompasses ideas, which could affect only locally and the need is local

As can be seen from the table, the case company classifies ideas by the core of the idea rather than the direct suggested benefit. This is very useful for the current study, as the search parameters of the IMS can be utilized effectively for selection of the relevant ideas.

The researcher selected search parameters based on characteristics of digital services identified in the literature review. Digital services require the use of digital technology, or they open up a new business (e.g. Williams et al. 2008; Yoo et al. 2012; Chowdhury 2015), which directed to select idea types to software and business. The case company's innovation management team helped to select of target idea concepts. At least part of the interaction should be digital, which means that selected idea concepts related to knowledge-intensive tasks or organizing of physical action, which directed the selection to usability, measuring and monitoring, service process, service tool, customer engagement, business model, and marketing. The search returned 97 ideas.

The idea platform can gather ideas more intensively by arranging idea challenges. These idea challenges are more descriptive and guided, and has instructions on what type of ideas are most desired. The researcher together with the case company innovation management team created a challenge, which lasted from the February 2017 to the March 2017. During the challenge, the users of the IMS submitted additional 16 ideas, which made the total number of ideas reviewed to be 113.

3.3.2 Ideation workshops

Digital service ideation workshops venue was a conference facility near the case company's headquarters. The language used in the workshops was English. The researcher was in the role of an observer and supported the facilitator for workshop preparation. The researcher documented notes during the preparation and workshops as intensively as possible. Documentation included notes of remarkable comments and statements, as well observed the atmosphere and overall spirit of the workshops. The decision not to record the workshop was made together with the case company's innovation management team, to ensure that all participants could feel fully free to ideate and be open-minded.

The innovation management team of the case company decided to arrange a series of workshops consisting a cross-functional team to ideate digital service offering, as well to find consensus regarding the first digital service concepts. The composition of the workshop representatives was decided to be peoples from support function A (digital development, research & innovation), service business and equipment business A. Innovation specialist working in the case company was selected to facilitate the workshop. The facilitator handled the main responsibility for the workshop practicalities, and the researcher supported him by preparing a part of the needed material for the workshop.

To be sure that the chosen approach was suitable for the context, the innovation management team also used external support and met a professional innovation consultant in the

February 2017. The topic of the meeting was to discuss if a series of ideation workshops would work for digital service creation. The consultant is one of the most recognized innovation facilitators in Nordic countries and has worked with the case company as well with other leading Nordic businesses to help their innovation, research and development activities. The meeting lasted for about two and half hours, which begun by familiarizing the consultant to the case company's business problem. He then continued to pressure the innovation manager, the innovation specialist, and the researcher to tell all underlying assumptions and frameworks. After this, discussion continued to available resources, expected results and next steps after the workshops. The case company's representatives explained the situation and asked that the consultant would help the facilitator in workshop preparing. Lastly, he confirmed that the workshop approach would be a suitable way to work.

The preparation for the workshops was carried out over a period of four weeks, during which researcher had regular meetings with the facilitator and the case company's business designer and the innovation manager. The goal for the preparations was that during the workshop it would be possible to rapidly ideate solutions for identified problems, as well see old problems in new light and find ideas proactively. In total four meetings were held to prepare the workshops, where shortest was one hour and longest two and half hours. Workshop preparation started by analyzing the problems the case company knew about their customers. Preparation phase included extensive pre-work of reviewing existing ideas, design concepts and discussions with employees carrying out on-site user interviews and observations. During this time, the researcher and the case company employees refined the ideation framework and decided duration and composition of the workshops. Also, the researcher documented all relevant ideas, identified problems, and customer insights, so they were possible to use in the workshops.

Two workshops were carried out, first was held at the beginning of the April 2017 and second at the end of the same month. Duration of first was approximately eight hours, and second four hours, which outlines are presented in Appendix 1. Before the first workshop, the organizing team assigned a pre-work to workshop participants. The participants were asked to find and explain their favorite product related digital service. In total six participants returned pre-work tasks, which template Appendix 2 presents.

In total ten employees of the case company and the researcher attended from technology and product management, industrial design, and innovation management. The people were the same in both workshops. Participants of the workshop were selected based on their roles in the case company as well their experience. The goal was to gain such a group, which had been gathering as many valuable insights as possible and had personality, which supports creative environment. Therefore, the workshop participants represented a cross-functional team consisting persons with frontline background from equipment sales, service management, and technical customer service. Another group was

support function A employees, who had conducted both customer and on-site user interviews and observations. Finally, also technical expertise was represented from the case company's digital platform development. Table 3.3 presents participants of the workshops.

Table 3.3: Descriptive information for workshop participants.

Position	Placement in the case company	Role in workshops
Innovation specialist	Support function A	Facilitator
Thesis worker	Support function A	Observations and support
Innovation manager	Support function A	Participant
Business designer	Support function A	Participant
Industrial design manager	Support function A	Participant
Industrial design expert	Support function A	Participant
Director, Technology platform	Equipment business A	Participant
Director, Digital platform development	Support function A	Participant
Product manager	Equipment business A	Participant
Product manager	Equipment business A	Participant
Leadership development program participant	Service business	Participant

Participants documented the actual results of the workshops (i.e. ideas) by first writing raw ideas on post-it notes. The case company's IMS was utilized to document developed ideas, and all post-it notes were collected and scanned to electronic form for further analysis by the researcher.

The workshop began by reviewing the goals and the overall process. After this, the researcher familiarized the workshop participants to the topic further by explaining what digital services delivered along equipment means with some examples of hybrid-offerings described by Ulaga & Reinartz (2011), where the service part is a digital service. The briefing to the topic was carried out according to the professional consultant suggestion, that in order the workshop to be successful, the participants had to be familiarized to the business problem, as well to the contexts of digital services.

During the first workshop participants created a total of 118 new raw digital service ideas. At the end of the workshop, each participant had to select two or three raw ideas, which form a core of idea concepts which they would develop. The participants selected the ideas individually so that they were not allowed to take the same core idea. After this, the participants created two to three idea concepts to the case company's IMS and used complimentary raw ideas to define the digital service idea concepts further. In total 23 new idea concepts were created, and in the end, all participants commented and provided feedback to others idea concepts in the IMS.

Pre-work for the second workshop was to define idea concepts further using digital service idea template presented in Appendix 3 and provide feedback to others. Also, to ensure diversity and to maximize use of frontline employee's insights, participants were paired up, so one person from support function A was paired to the frontline employee to develop their idea concepts together further. Also, between the workshops, the researcher scanned all created post-it notes to digital form for later analysis.

Participants in the second workshop were the same as in the first one. The facilitator explained the goal of the second workshop, which was to review the ideas and then select the most promising ones for further development. The evaluation criteria selection for the ideas were made based on the empirical literature of idea evaluation, the case company's innovation management team and the external consultant.

Assessment process during the workshop was an open discussion, where first the ideas in one idea group were presented briefly to others by the idea concept developer, after which participants gave their feedback and comments. The initial feedback after presenting an idea before the evaluation stayed on the generic level and mostly around customer need and problem. The participants gave only little focus for technical details. Once actual evaluation had to be made for ideas in a particular group, participants considered all aspects in a much more detailed manner (e.g. laws related to working with industrial machines, technical feasibility, and available resources), followed by listing main assumptions, which created a diverse conversation. The researcher took pictures of the evaluation results and notes of the discussion for further analysis.

Industrial design manager, industrial design experts, the business designer and the innovation manager made the final selection of ideas which would form core digital service concept in a meeting at the end of May 2017. Main considerations at the meeting were technical feasibility, available resources, and regulations. The meeting began by briefly reviewing all 54 unique idea concepts to make sure that the evaluation took all relevant factors into account. All agreed that the evaluation made in the workshop was primarily valid, but there were not enough resources to develop all concepts. This shortage of resources led to final assessment and idea concept screening before concept refinement. Three more idea concepts were decided to leave on idea level at that point and four digital

service concepts, which the case company's industrial designers had already conceptualized, was included in the final phase.

3.3.3 Benchmarking interviews

Benchmarking means the process to identify the maximum standard of excellence for offerings such as products, services, or companies' processes, and then making the improving actions to reach those standards (Elmuti & Kathawala 1997). These standards are typically called best practices, which have been tried to identify for organizing innovation- and development processes for already decades (e.g. Cooper & Kleinschmidt 1995; Cooper 1998). Benchmarking can also be used as a method of identifying new ideas and therefore a mean to meet the expectations of customers and users (Elmuti & Kathawala 1997). In this research, the focus was to carry out industry benchmarking, which for example Elmuti & Kathawala (1997) summarizes to be performed externally against industry leaders. The selected benchmarking companies should have common technological and market characteristics, or some other key similarities.

Digital service idea concept benchmarking was carried out in world's leading industrial technology trade show Hannover Messe held in Hannover, Germany at the end of April 2017. Due to the newness of the research area, the case company decision makers concluded that newest information about industrial equipment offerings consisting digital services is not possible to retrieve from the internet, so leading technology trade show in industrial context was the most likely place to find the latest offerings and new digital services. Industry leading companies launched their innovations to the market at Hannover Messe, which made this trade show a natural choice for benchmarking, where the researcher and the case company innovation manager visited for three days.

Hannover Messe was held after the digital service workshops in the case company, so the idea concepts which the case company had created were known. Therefore, it was possible to assess their novelty and value to other possible existing digital service offerings in other industries. The researcher and the innovation manager selected for the benchmark industry industrial pneumatic air compressor OEMs. The Hannover Messe had one-third of the exhibition space dedicated for pneumatic air, which indicated the relevance of the industry.

For the benchmarking only OEMs of compressor were selected, as many of the case company's customers also had pneumatic air compressors. The selected benchmarking industry would most likely be further in digital service development than the case company's industry since they were further in their servitization transformation. The researcher and the innovation manager made this conclusion, as Lerch & Gotsch (2015) had found the relation between industrial manufacturing organization servitization and digitalization transformation. The researcher and the innovation manager familiarized themselves to dynamics of pneumatic air industry and realized that the manufacturers were further than

the case company in their servitization transformation identified by Oliva & Kallenberg (2003). Also, leading companies in pneumatic air industry had similar existing remote service offering as the case company. As companies in pneumatic air industry were further in their servitization strategy, there was a good chance that they might be offering pure digital services before the case company.

Selected interviews were three largest OEMs in the industry (according to that benchmarking should focus to identify the highest standard of excellence for offerings). Also, to gain diversity, one start-up company which is in the process of commercializing possibly disruptive air compression technology, was selected. The benchmarking companies are referred as AirComp A, -B, -C and -D. Selection of the interviewees happened at the trade show by visiting companies stands and asking the person, who had the best knowledge regarding their digital solutions. Nationalities of the interviewees from AirComp A and B was German, from AirComp C British and from AirComp D both were Finnish. Company descriptions and people met at the trade show are presented in table 3.4.

Table 3.4: Descriptive information for benchmarking interviews.

Company	Size and description	Persons met	Role in the company
AirComp A	Over 10 000 employees, operates in multiple industries, annual revenue over 10B€	Head of digital solutions	Leader of digital development in pneumatic air division
AirComp B	501-1,000 employees, only pneumatic air industry, annual revenue 100-500M€	Product manager	Product manager of new flagship air
AirComp C	501-1,000 employees, only pneumatic air industry, annual revenue 100-500M€	Sales engineer	Project sales for large customers and process facilities
AirComp D	A start-up, which has developed new potentially disruptive technology innovation for pneumatic air industry	Chief executive officer	Leader of the company
		Development manager	Responsibility of strategic partnerships

The interviews consisted three themes; discussion about digital services delivered along equipment offering, the interviewee company's digital service offering and why they do offer or do not offer digital service along with their equipment. To gain deeper insight, a series of additional questions were asked depending on course of the interview. The researcher took notes of the interviews and collected the main arguments the interviewees made for later analysis.

3.3.4 Case company interviews

The researcher, innovation manager, and the business designer presented the most promising digital service concepts to the case company's employees, who are responsible for decision-making in the relevant business units and support function A in the case company's headquarters. Two of the decision makers, product manager A and director of digital platform development did also participate in workshops. As the results, and discussions around the topic, are confidential, it was not possible to record the interviews nor comments during the presentations. Table 3.5 presents a descriptive summary of the case company decision makers.

Table 3.5: Descriptive information for the case company interviews.

Position	Duration of the result presentation and interview
Executive vice president, support function A	One hour
Chief officer of support function A, Director of research & innovation, support function A	One hour
Director, equipment product management	One and half hour
Director, service product management	One and half hour
Product manager A	One and half hour
Director, Digital platform development a46nd Concept owner, Digital platform development	One hour

The researcher was not able to participate in the results presentation with equipment product management director but collected the notes later from the case company's innovation manager and business designer. Purpose of result presentations was to present the digital service concepts, which the development team planned to propose to the development phase, to the decision makers. The conversation was carried out during the presentation out of which the researcher took as many notes as possible. The interview after the presentation was loosely structured to find 1) what the person thought about the concept (i.e. what kind of competitive advantage digital service offering would create), 2) what aspects of the concept would require further development and examination and 3) would they give go/no-go evaluation in meeting, when it would be the time to decide is the concept moved to development project.

The decision to not use formal assessment criteria was chosen according to Magnusson et al. (2014) findings, that at the front end of innovation competent persons can make decisions and evaluations on concept level ideas based on their intuition. Also, the concepts were already evaluated to be feasible and to offer customer value by the case company's experts, so the decision to move concept to development phase entails complex strategic questions. The researcher, innovation manager, and the business designer of the case company assessed the feedback directly after the interviews.

3.4 Data analysis

Throughout the empirical part of the research, data analysis was carried out at the same time as data gathering. This research encompasses multiple data gathering techniques and -sources to gain a holistic view of the topic area, and it was necessary to use the results from the previous step in next the empirical phase. Simultaneous data gathering and -analysis is possible in qualitative business research, especially when more than one method is used (Creswell 2013). Also, the quality of data analysis is strongly related to how well the researcher has familiarized the material (Hirsjärvi & Hurme 2008, pp. 140 – 150), which further suggested that specially written notes were interpreted directly after their collection.

The researcher carried out qualitative data analysis by dividing and decoding the gathered material into small parts, classified the material by its characteristics and then structured these classes into larger frameworks following Hirsjärvi & Hurme (2008) suggestions. Then the analysis was reviewed and synthesized, where the researcher took notions and new information from the material into digital form. The analysis process for ideas illustrated in Figure 3.2 followed roughly a pattern of description, classification, and combination.

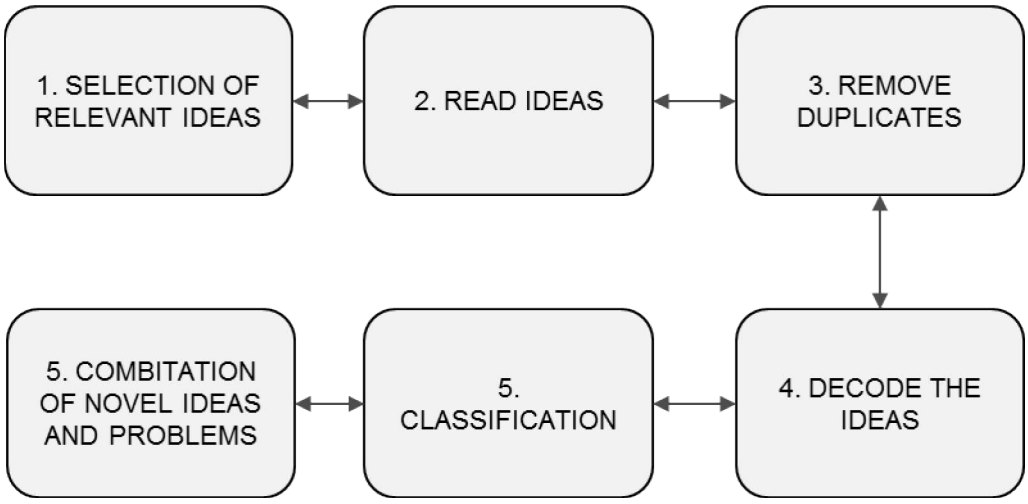

Figure 3.2: Framework for idea analyzation.

The data analysis began by printing existing digital service related ideas from the case company's IMS on paper. After this, the researcher read the ideas several times, removed clear duplicate ideas, and decoded unique ideas into individual unique raw ideas, which presented opportunities and customer and user problems. These raw ideas were then classified and combined to digital service idea concepts. Also, the researcher analyzed that would it be possible to utilize the IMS for sourcing digital service opportunities for the case company. The analysis was carried out by examining when ideas were created and who had submitted them as well if the ideas were customer problem or proactive opportunity oriented.

It was also needed to create an ideation framework for digital services, which could be used to create new ideas as well to conceptualize raw ideas. The researcher chose to follow Aurich et al. (2007) ideation matrix principle for the task introduced in Chapter 2.3.4. However, as elaborated in Chapter 2.3.3 customer and user-centricity is a necessity when creating digital services, which made it necessary to modify the framework.

First, the process-centric equipment lifecycle conceptualized by Hastings (2010), was placed on horizontal axel of the matrix. The case company's innovation manager, innovation specialist and business designer further refined the lifecycle and removed unnecessary stages. This refinement was done to avoid forcing ideas to lifecycle phases, which are non-relevant for the case company's equipment offering. Then, following suggestions of Abrell et al. (2016) and design thinking practitioners, the primary user of the digital service was emphasized by placing them on the vertical axel. The case company innovation manager and the business designer had already identified relevant customer stakeholders in earlier projects, which allowed the researcher to place them to the matrix directly. Figure 3.3 illustrates the ideation framework for industrial digital services constructed for this research.

		Process-centric lifecycle phase				
		Purchase	*Delivery*	*Usage*	*Maintain*	*Renewal & Disposal*
Digital service user	*Decision maker*					
	Managers					
	Operators					
	Service technician					
	Third parties					

Figure 3.3. The framework used for digital service ideation.

By utilizing the developed framework, it was possible to create the digital services in the workshop and also to recombine the existing raw ideas. Next, it was necessary to analyze the relation of digital service idea concepts to the case company's physical equipment offering. After all, the goal was to identify digital service opportunities, which would have a connection to the physical product. Since framework illustrated in Figure 3.3 does not take into account relative dependence between digital service and the physical offering, it was necessary to create another framework for identifying digital service ideas, which are in scope of the current research. The second framework presented in Figure 3.4

utilizes the main classes of digital services defined by Chowdhury (2015) as well roughly the primary user of the digital service.

		Main classes of digital services		
		1. Independent digital services	*2. Digital platform dependent digital services*	*3. Specific product dependent digital services*
Digital service user	*Customers*			
	Users			
	Third parties			

Figure 3.4: Framework to analyze the relation between digital service and physical equipment.

The results of data-analysis are organized first to show digital service idea concept creation. After this, the digital service concepts and the identified strategic opportunities, which the digital service idea concepts create, are presented. The final result, which is the development roadmap, describes that how the case company should pursue the identified opportunities. Figure 3.5 illustrates the sequence of the results.

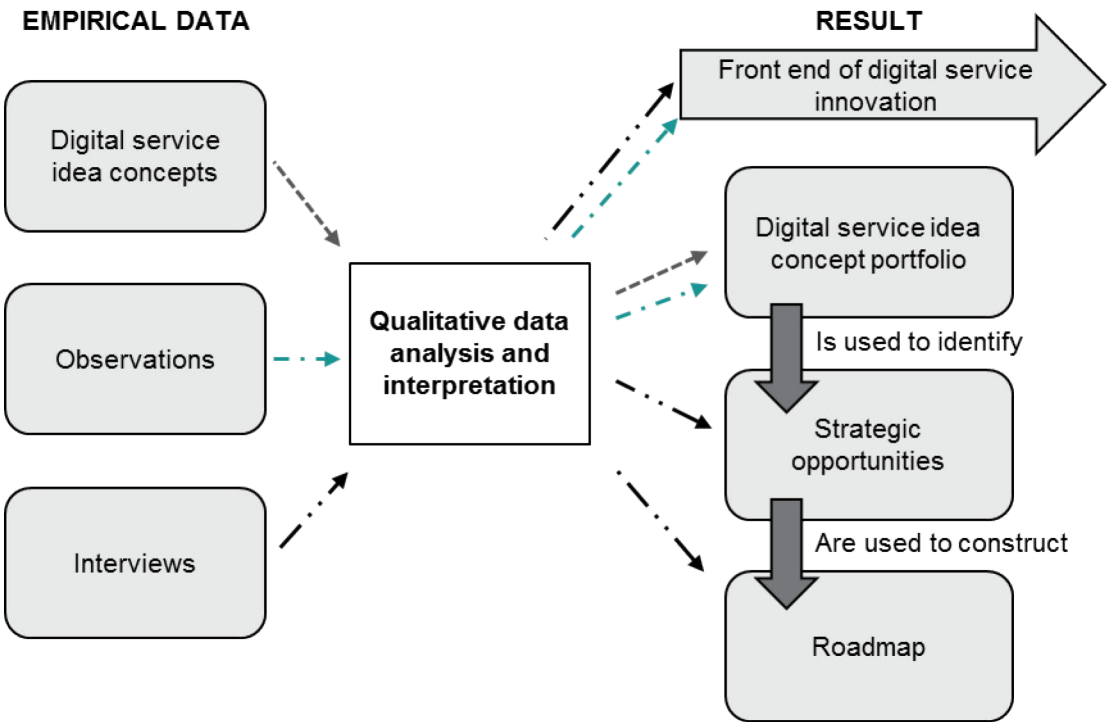

Figure 3.5: Integration of findings and sequence of the results.

As the Figure 3.5 shows, data-analysis of this multi-method research required to integrate empirical data and findings in multiple ways. First, findings from observations and semi-structured interviews are integrated with the existing front end of innovation literature to construct the overall process for front end of digital service innovation. Then, findings from digital service ideas and observations are combined to refine digital service idea concept portfolio. After this, semi-structured interviews and digital service idea concepts were integrated to identify and classify digital service opportunities. Finally, the researcher created the roadmap for digital service development by integrating findings from semi-structured interviews to identified strategic opportunities.

Finally, the actual content of digital service idea concepts was confidential, it is required to refer ideas in the result section with identification numbers (IDs). The researcher gave IDs to unique digital service idea concepts by organizing them in a random order and giving them numerical values.

4. RESULTS

This Chapter 4 presents results of the empirical part of this study. The chapter begins by introducing the overall front end of the innovation process and methodology for the digital service idea creation and ends to the suggested roadmap for the case company.

4.1 Front end of digital service innovation

The front end of digital service innovation in the case company consists three phases; *1) problem mapping 2) problem solving and 3) concept validation.* The first phase, problem mapping, was carried out primarily by the case company's innovation manager, the innovation specialist, the business designer and the researcher. Key tasks in this phase are to carry out *background analysis* and *definition* in an iterative manner.

Next, in problem solving phase, key content is *ideation*, *idea development, evaluation,* and *concept creation.* The transition to problem solving phase was evident. However, if the ideation results would have been disappointing, it would have been necessary to return towards background analysis. The process is iterative between phases and steps.

Finally, third main phase in the front end of digital service innovation is *testing*. The empirical part of this research ended to second main phase, and the case company continued to the third concept validation phase. These phases are elaborated further in upcoming chapters, and Figure 4.1 presents the overall front end of digital service innovation.

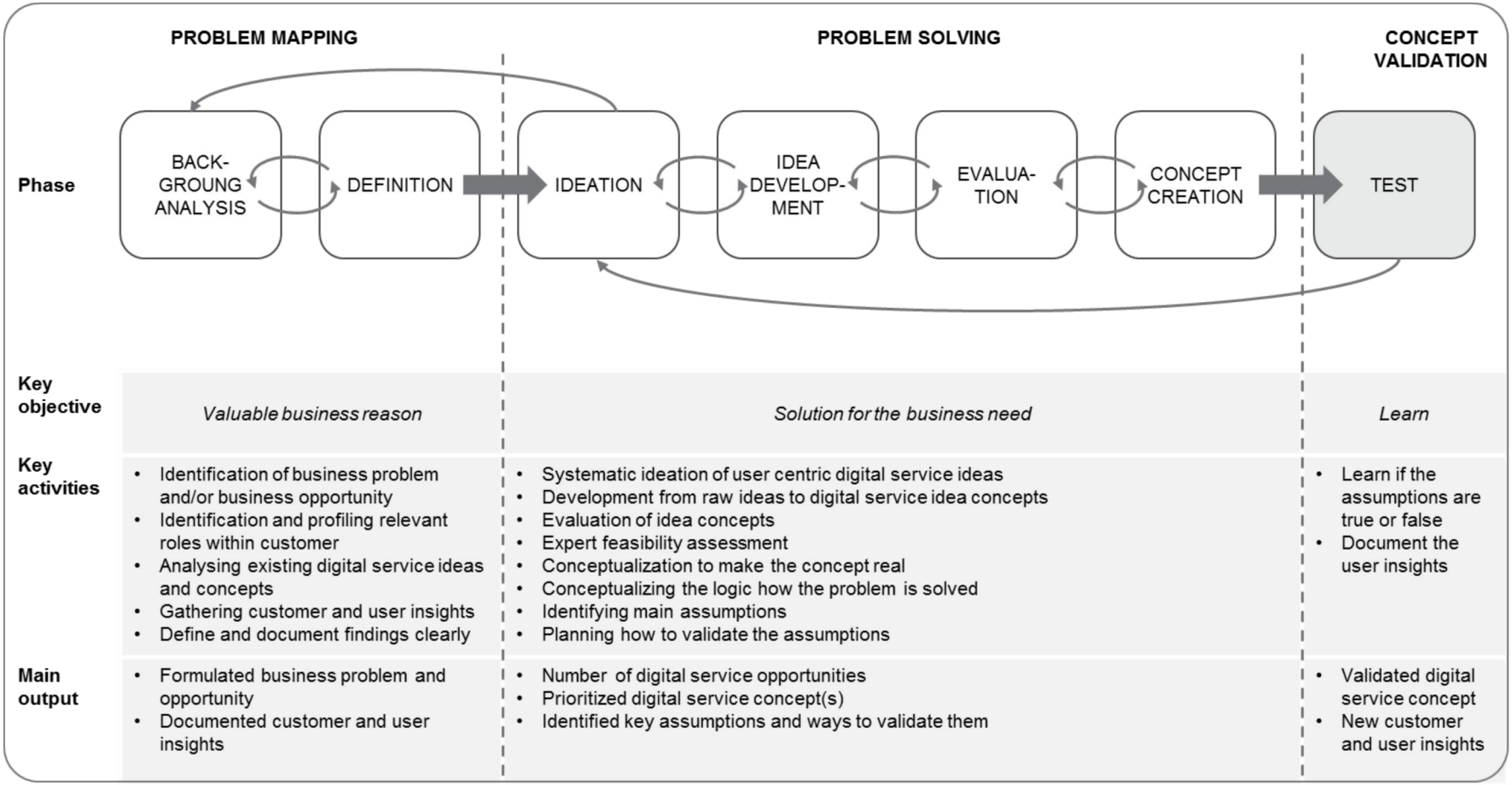

Figure 4.1: Front end of digital service innovation in the case company.

4.1.1 Problem mapping

Key activities in ***background analysis*** are the identification of the case company's business problem and business opportunity, identifying relevant stakeholders and profiling them, gathering existing customer and user insights and collecting, as well analyzing, existing digital service ideas. The first phase is crucial for the whole innovation process. If the business problem is not worth to be solved or the opportunity is not lucrative enough, it will be difficult to gather the needed resources within the organization for problem solving. In a way, the organizing team must create a sense of urgency to get people to commit to the creation of the digital service concepts. In the case company's situation both the business problem must be solved, as well the business opportunity is worth to pursue, which helped the organizing team to gather resources for the upcoming phases. The final formulation of the case company's business problem and opportunity are:

Problem: Our equipment offering should contain a new type of non-tangible value propositions to differentiate from the competition.

Opportunity: Being present in customer's life the whole equipment lifecycle, regardless if the customer is our service customer or not, can increase customer loyalty.

Background analysis is carried out iteratively with ***definition*** phase, where the collected insights and information is reframed and defined to documented and clear form. The researcher, the innovation manager, the business designer and the innovation specialist carried out problem formulation. The innovation manager and the business designer had identified relevant customer stakeholders and profiled them in prior projects, which again made the definition phase faster and more streamlined.

The researcher proceeded to gather existing customer and user insights and collecting, as well analyzing, existing digital service ideas from the case company's IMS. As said in Chapter 3.3.1, all digital service ideas were relevant to use from 2011, since the case company had made only concept level development to the ideas. The case company's IMS has gathered digital service related ideas globally. The ideas came from Finland, India, United States, Australia, United Kingdom, Russia, Singapore, South-Africa, Brazil, China, Germany, Hungary, Japan, Netherlands, Norway, Sweden and the United Arabic Emirates. Even though the majority of ideas came from Finland, India, United States and Australia, the IMS is providing a global source for ideas. Overall, employee's activity to ideate digital services is growing. Figure 4.2 shows the number of digital service ideas submitted annually from the beginning of 2011 until the March 2017.

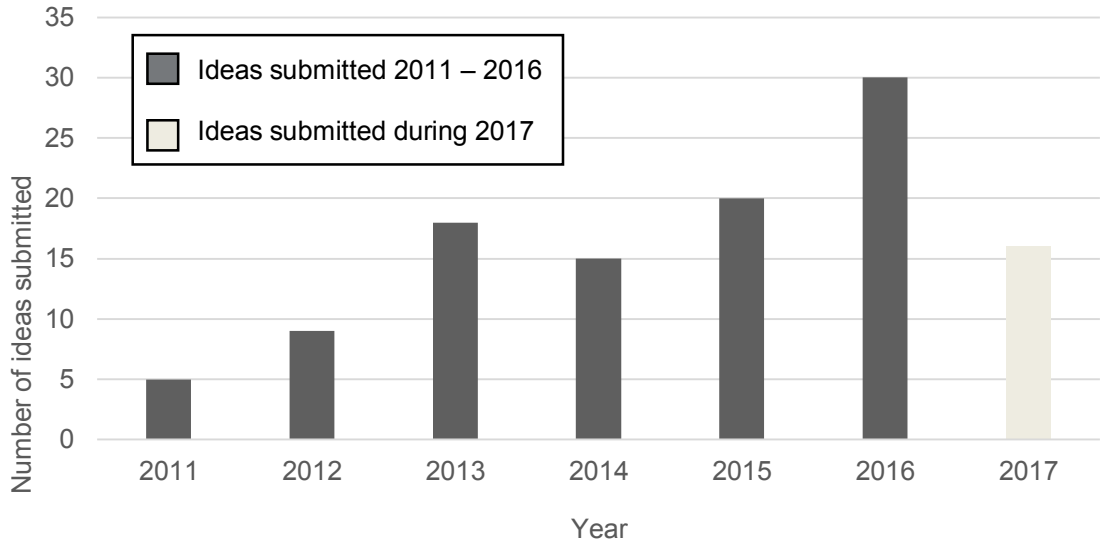

Figure 4.2: Annually submitted digital service related ideas.

Figure 4.2. gives reason to expect, that during the year 2017 the amount of digital service related ideas will surpass the year 2016, since only first three first months of 2017 were included in the analysis. The analysis does not consider if the submitted ideas are duplicates or unique ideas.

The case company's employees are active to ideate digital services, and the topic is increasingly valid amount industry practitioners. Also, the need for digital service development had been realized by several employees already many years ago. For example, one employee started his idea concisely (from the year 2013):

"Service techs and people who work with the equipment does not always have manuals with them. What do they have? Smartphones."

A diverse group of 105 case company's employees submitted the ideas. Ranks and organizational positions of idea submitters varied from regional vice president to service technician. Employee's work content was equally diverse; ideas were coming from software developers, platform directors, product and service managers and even machinists. The managerial level was most common employee type to submit digital service related ideas.

The employees who submitted the ideas represented all three business areas and support function A. Also, a few ideas came from other support functions (marketing and human resources). It was not possible to find the position for 15 idea submitters, who had created 20 ideas since they no longer worked for the case company. Figure 4.3 illustrates the sources and types of digital service related ideas found from case company's IMS.

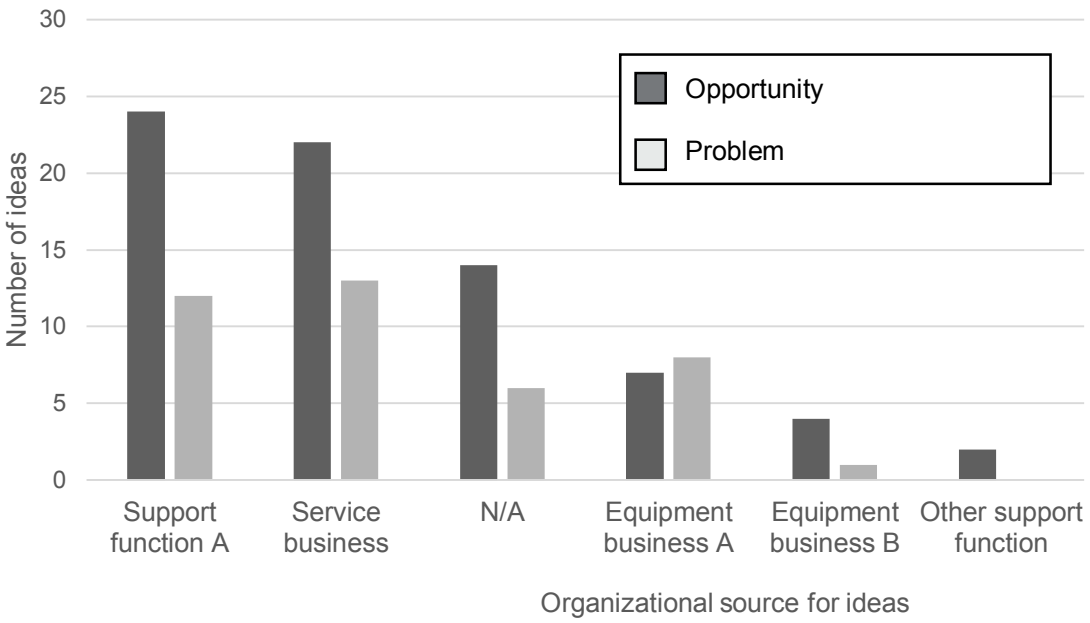

Figure 4.3: Organizational sources for digital service related ideas.

As the Figure 4.3 shows, support function A has been the most active to submit ideas. This is most likely due the function is responsible for technology development, and digital services utilize digital technology. It was also easy to notice the power of combining cross-functional teams for idea creation. Quality of ideas was remarkably better when there were employees from a business unit and support function A than employee(s) from either one alone. The cross-functional teams could refine customer problems and challenges related to the idea further. An idea submitted by a cross-functional team of three employees consisting service sales manager (Australia), service product manager (United States) and development engineer (Finland) from the year 2014 gives an excellent example of this analysis:

"Increasing the digital interaction with our customers is increasingly important. The smartphone and tablet technologies are now allowing us to do this. The question is, how to engage the users so that they would be willing to use our apps?"

Indeed, ideas which diverse teams submitted were more mature than ideas by a single presenter. Still, all ideas encompassed insights of digital innovation, such as using users own smartphone to replace a remote control. An employee from service business suggested that a possible solution is to create a digital service encompassing user interface:

"...and smartphone becomes the remote."

The ideas were encompassing both user and customer knowledge, and they were both problem and proactive opportunity driven. In total, 38 ideas were primarily user-centric, 63 customer-centric and 12 encompassed both views equally. The main driver in 40 ideas

was customer or user problem and in 73 proactive opportunities, without clear problem definition. Figure 4.4 illustrates how digital service ideas were divided.

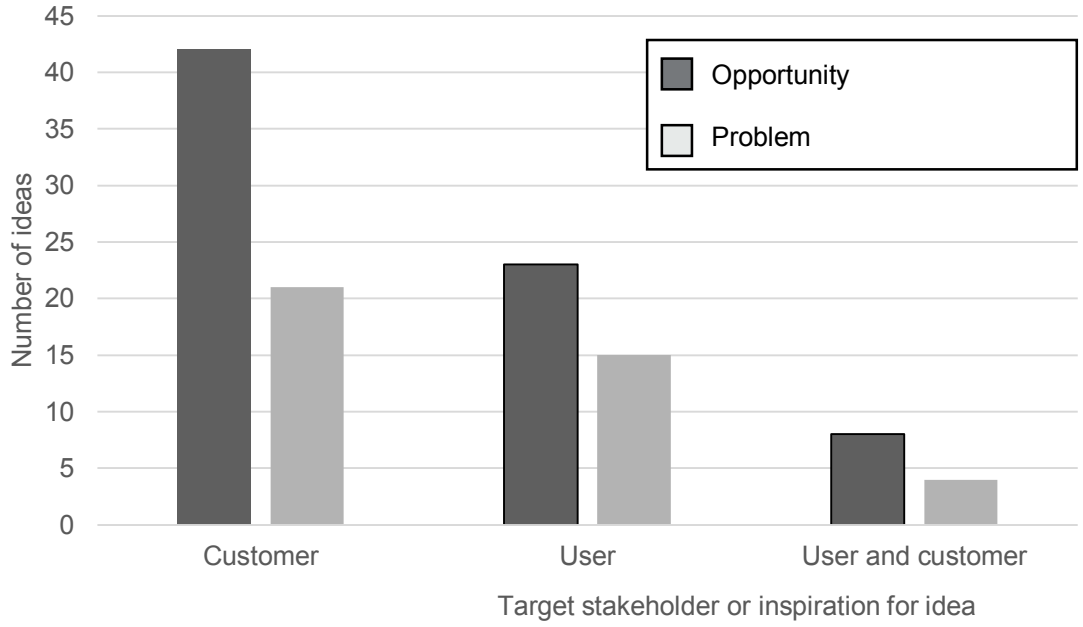

Figure 4.4: Number of customer and user problem and opportunity ideas.

From Figure 4.4 it can be confirmed that for the case company acquiring customer knowledge for digital innovation is easier than acquiring user knowledge. While reading and analyzing the digital service related ideas, the researcher also found that when the core of an idea was customer problem or opportunity, they typically were targeted to decision makers or managers. A good example of this was an idea, which suggests the creation of new intuitive sales application:

"A customer asks for a new [removed] – but very few anywhere in the world can accurately say what [removed] they need. "

Then there were ideas, which encompassed both user and customer views. In fact, some ideas were opportunities to prepare for the issue of customers and users differing needs. Following idea already encompasses generative feature of digital innovations and the customer orientation to equipment lifecycle:

"3D data is especially useful because stakeholders around the product might vary, but the 3D representation of the product remains fairly similar for everyone during the product lifecycle. "

Different stakeholders found in the ideas were *customer's decision maker, manager, user, in-house service technician* and *third parties*. The differing goals of a variety of stakeholders along equipment lifecycle did also come up directly in meetings with case company representatives when planning the workshops. The insights found from ideas

confirmed a similar framework which the case company's innovation manager and business designer had already developed. Still, the same information would have been available, yet in not so easy to understand form, in case company's idea platform.

Re-bundling the pieces from raw ideas, resulted to 22 unique idea concepts, encompassing customer or user need and problem, the solution to the problem and a description of how the idea would work. Also, dozens of raw ideas did not form a total idea concept.

4.1.2 Problem solving

The goal of active and systematic ***ideation*** is to cover the entire equipment lifecycle, so it is possible to find opportunities to enhance the equipment offering for all customer's stakeholders. Another important characteristic of this phase is to select a diverse group of people to attend the workshop. It is important to gather people, who have knowledge from software development and digital technology, front-line employees who are regularly in contact with customers and employees, who have conducted on-site user interviews and observations. By having this kind of knowledge combined to feed ideas and insights, with the help of a facilitator, it is possible to create a lot of digital service ideas in one full day.

This step began in the case company by organizing a full day workshop were identified, and defined, customer and user insights and problems stimulated idea creation. Now, the participants are guided to ideate fast a wide array of digital service raw ideas for a variety of users. The framework allows the facilitator to guide the ideation from one phase to another. This way participants focus is in one lifecycle phase at the time. During the session, all raw ideas were placed in the ideation matrix, where it is possible to see if patterns start to emerge. This technique is highly efficient and results in the creation of hundreds of raw ideas. For example, one workshop participant cheerfully said after the halfway of the workshop:

"Come on; there is nothing new we can come up, can't we just select good ideas and start working?"

Still, the participants created another 40 ideas after this. Once the facilitators had directed the participants through the whole ideation matrix, the created raw ideas were combined to reduce duplicate ideas already at this stage. This phase required expertise and right mindset from the workshop participants. It is challenging to find consensus with such uncertainty.

Idea development phase relies on the workshop participants and the organizing team's efforts. At the end of the workshop, each participant chose two to three core ideas, which they defined further. Between the first and second workshop, the ideas were developed further with the help of template found in Appendix 3. Therefore, the first screening of ideas happened very informally and intuitively. However, to make sure that the

participant did not miss potentially great ideas at this point, the researcher gathered all individual raw ideas, which were not selected by the workshop participants. After this, the researcher grouped and developed all individual raw ideas according to the idea development template. In the case company's workshop, the participants selected 22 unique ideas, and the researcher conceptualized remaining 32.

The topic of the second workshop was to present developed ideas to others and then ***evaluate*** and select those, which formed the initial digital service concepts. The evaluation was done in role-based idea groups so that the participants would equally consider all stakeholders. The idea groups for the case company's digital service ideas were a *customer* (decision maker and managers)*, user, service technician* and *stand-alone digital services.* Multiple stakeholders can use same digital service, which makes it essential that the evaluation was done based on the *primary user* perspective. This is the role, which interacts the most with the digital service, not the one who would benefit from it the most. This choice was made based on the case company's experts view, that it is essential to keep the evaluation process as clear as possible and avoid confusion – it might be unclear who would benefit the most (i.e. user or the customer), but the primary user is easy to see.

Before conceptualization, the key team had to gather and review the selected idea concepts carefully, and assess if they solve the identified business problem and make the business opportunity possible. In this meeting, the case company's experts revised both the legal and technical feasibility of the idea concepts and selected the ideas which would form the core elements of the digital service concept. To carry out the transition to conceptualization smoothly, all ideas created in the workshop should be conceptualized by the organizing team – otherwise, it is hard to reach consensus, confidence and possibly select more ideas to the core concept.

The primary user of the digital service idea gave the perspective for ***conceptualization***. The digital service ideas were conceptualized to show how digital service would solve identified user and customer problem. The concept creation could be done on top of one developed idea but in the case company the digital service concept combined in total five digital service idea concepts as core elements. The actual conceptualization work was done by industrial design experts, while business logic for digital services was refined and developed by the innovation manager, the business designer, and the researcher. Indeed, it is also essential to document exactly how the business problem is solved and how the concept makes it possible to realize the business opportunity, as well to identify the underlying assumptions. Diverse competence and understanding the customer and user context are critical in conceptualization phase.

After defining the digital service concept and the problem solving logic, the results were presented to relevant decision makers and experts internally. After these presentations, the focus was to find out all assumptions that the decision makers identify in the concept.

At the end of conceptualization phase, the team should have solid digital service concept(s) at their hand with identified underlying assumptions.

4.1.3 Concept validation

Concept validation phase was identified based on the interviews after result presentations for the decision makers. Key of the concept validation is to ***test*** all the underlying assumptions identified at the end of conceptualization. Multiple possible techniques are possible. Empirical phase of this study ended before concept validation phase, and the case company continued to this stage after the research. The key focus was still easy to identify – there should be a way to provide data based answers to key assumptions related to the digital service concept(s).

All decision makers noted, that even though ideation, idea evaluation and digital service concept creation entailed a considerable amount of customer and user knowledge, some testing had to be carried out before development project. For example, one decision maker from service business noted:

"How fast we can start the pilot for [removed]? I think we could quite easily find new test customers from Australia, and a two-month pilot would make this a lot more solid."

Based on discussions with the case company business designer, it is also possible to describe what would happen after the testing. The concept would move to the development project, which would be carried out using some structured technique, or the team would be jumping back to the ideation phase. The ideation would be carried out fueled by new insights gained from the testing and the next refined concept would most likely to be better.

4.2 Digital service idea concepts

This chapter begins by presenting the evaluation of the digital service idea concepts. Since the assessment of the idea concept has a significant effect on the overall performance of the innovation process, the actual evaluation outcomes are viable results for this research. After the evaluation, the chapter presents digital service idea concept portfolio.

4.2.1 Idea concept evaluation

The assessment of digital service ideas was not consistent process in the case company. Multiple idea concepts, which had been a long period in "to do" list for the case company were left out from the evaluation and they were automatically included in the digital service concept. Much confusion would have been able to avoid if these older idea concepts were also evaluated.

Evaluation criteria for digital service ideas were determined based on literature review and finally set during the preparation work for the workshop. Digital service should create non-tangible value propositions, which directed the focus towards the competitive measure of the *user and customer value* over the case company's future business value. This criterion represents differentiation (e.g. user experience, performance, saved time) in the eyes of the customer and user. Based on the case company's innovation manager, innovation specialist, and business designer expertise, a digital service which would facilitate user and customer value would differentiate the equipment offering from competition, strengthen the customer satisfaction and user experience.

Second selected evaluation criterion was *feasibility*. Feasibility means the case company's competence to develop digital service and overall technology readiness of the users and customers. For example, if an idea requires that the user would have their smart glasses, it would have been evaluated low on feasibility. Wearable technologies, such as smart glasses, have not yet become common and the case company cannot deliver a pair along each equipment delivery due to the price of these technologies. Also, the case company had realized that they are not able to educate the actual use of digital technology for the users. Therefore, people in developed countries should commonly own the required digital technology, and the technology has to be familiar to the majority of the population.

Novelty was a third considered evaluation criterion, but the innovation manager and the innovation specialist decided that the participants not need to consider novelty of digital service ideas at this point. The case company had a strong business need to create a feasible and valuable concept, and since the case company did not have existing digital service offering, evaluation of novelty would have been rather subjective. However, if the business problem to be solved would require emphasizing novelty, naturally, it should be evaluated as third criteria.

Figure 4.5 displays result of digital service evaluation for the customer ideas. All idea concepts chosen to be conceptualized are highlighted with dark teal. Ideas, which were evaluated to be too advanced by experts right now, but should be re-evaluated within near future, are highlighted with dark grey. Finally, ideas which were left on idea concept level right away due unfeasibility are white.

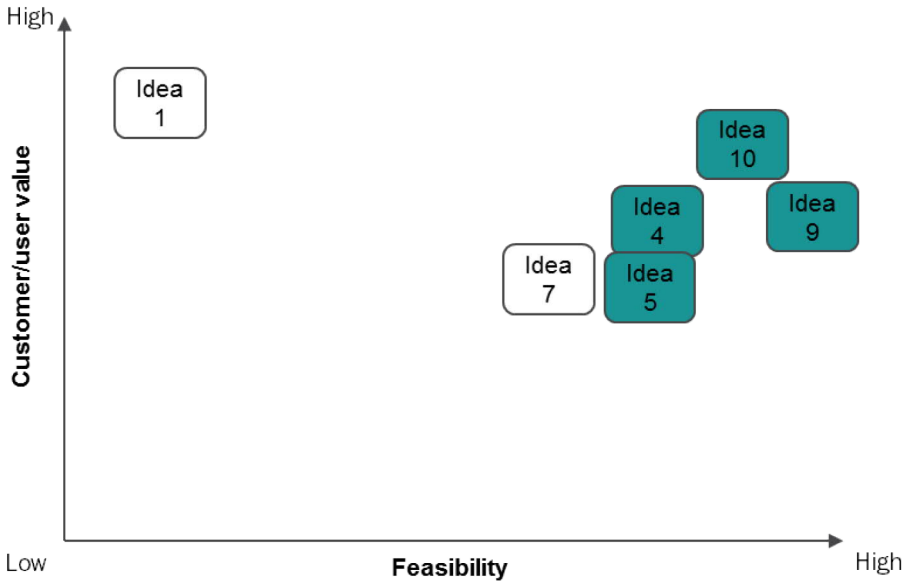

Figure 4.5: Result of evaluation for customer's idea concepts.

As can be seen from the figure, ideas for the customer were in general evaluated to create quite well value for customer and user. Still, the case company employees considered idea 1 to be such an advanced concept, that it would not be feasible to realize it. Therefore, the workshop participants chose ideas 10, 9, 4 and 5 to further development.

In the workshop, participants created ideas for both users and service technicians. This was due to the two stakeholder groups interacted with the equipment in different life-cycle phases (i.e. users mainly in operational phase and service technicians in maintenance phase). Therefore, the ideas were in their groups and evaluated separately. Figure 4.6 shows the result of user idea evaluation.

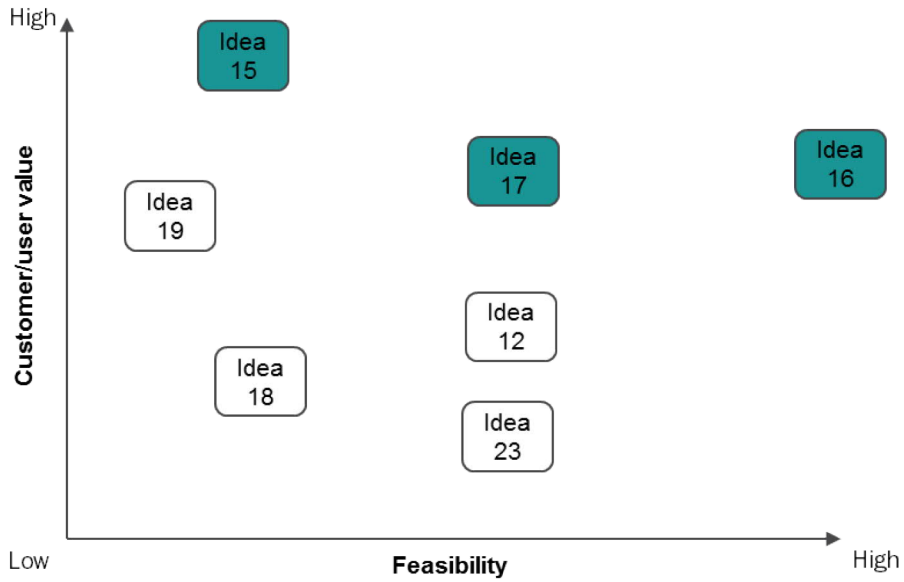

Figure 4.6: Result of evaluation for user idea concepts.

In user idea concepts the evaluation process was similar as in customer – two concepts were left out from the evaluation. Interestingly, idea 15 was selected to development but later found unfeasible from legal and technical reasons. Still, it was relatively easy to see which concepts were shown to create value at this point. Next, Figure 4.7 illustrates the result of idea evaluation for a service technician.

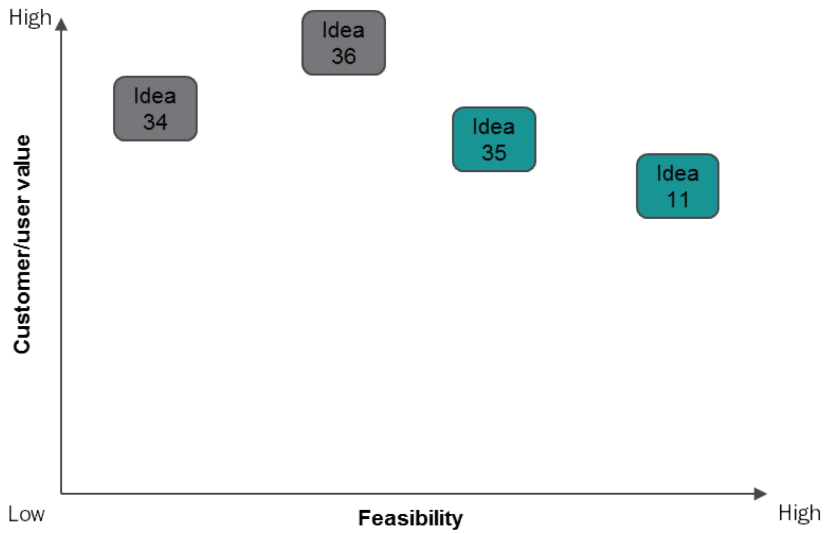

Figure 4.7: Result of evaluation for service technician idea concepts.

Again, all ideas for service technician were evaluated high on value, but two idea concepts seemed difficult to develop from a technical viewpoint. The participants concluded, that the effort which is required to realize idea 36 is too high when there are such low-hanging fruits in ideas 35 and 11. Finally, Figure 4.8 presents the evaluation for stand-alone digital services, which were close to a new business opportunity.

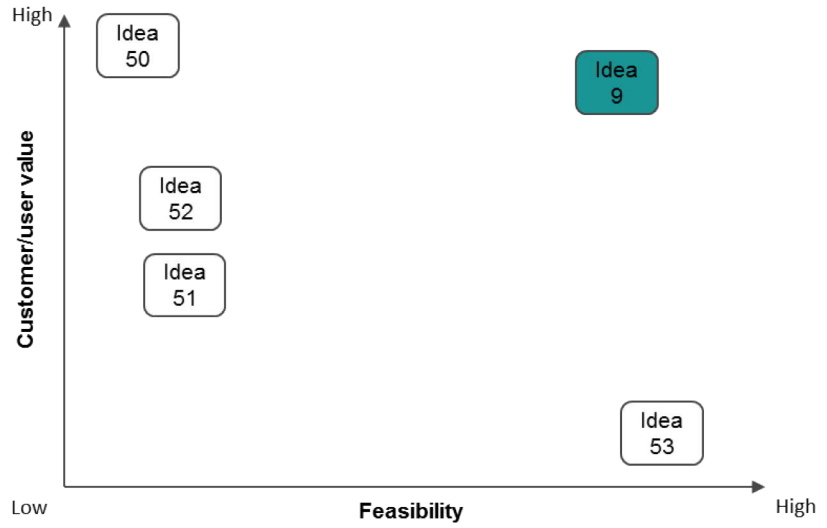

Figure 4.8: Result of evaluation for stand-alone digital service idea concepts.

To conclude, evaluation of digital service ideas was done using only two dimensions in the front end of digital service innovation. The approach is right when the goal is to find first concepts to be developed. Still, it would be better if all unique ideas would be evaluated, rather than cutting corners – after all the evaluation phase has significant effect to the final concept.

4.2.2 Digital service idea concept portfolio

This chapter presents the digital service idea concept portfolio, which the researcher constructed. The work to construct digital service idea portfolio begun by placing all created novel ideas on the ideation framework by identifying the primary user for the idea concept as well the target lifecycle phase for the digital service idea.

The user for most of the ideas in early phases of equipment lifecycle is customer's decision makers (i.e. prior purchasing to support decision-making). Then, during usage and maintenance phases the focus shifted customer's managers, equipment users, and service technicians. Finally, once the equipment starts to require replacement or modernization actions, customer's decision makers are again emphasized. Figure 4.9 displays all created digital service idea concepts on the equipment lifecycle.

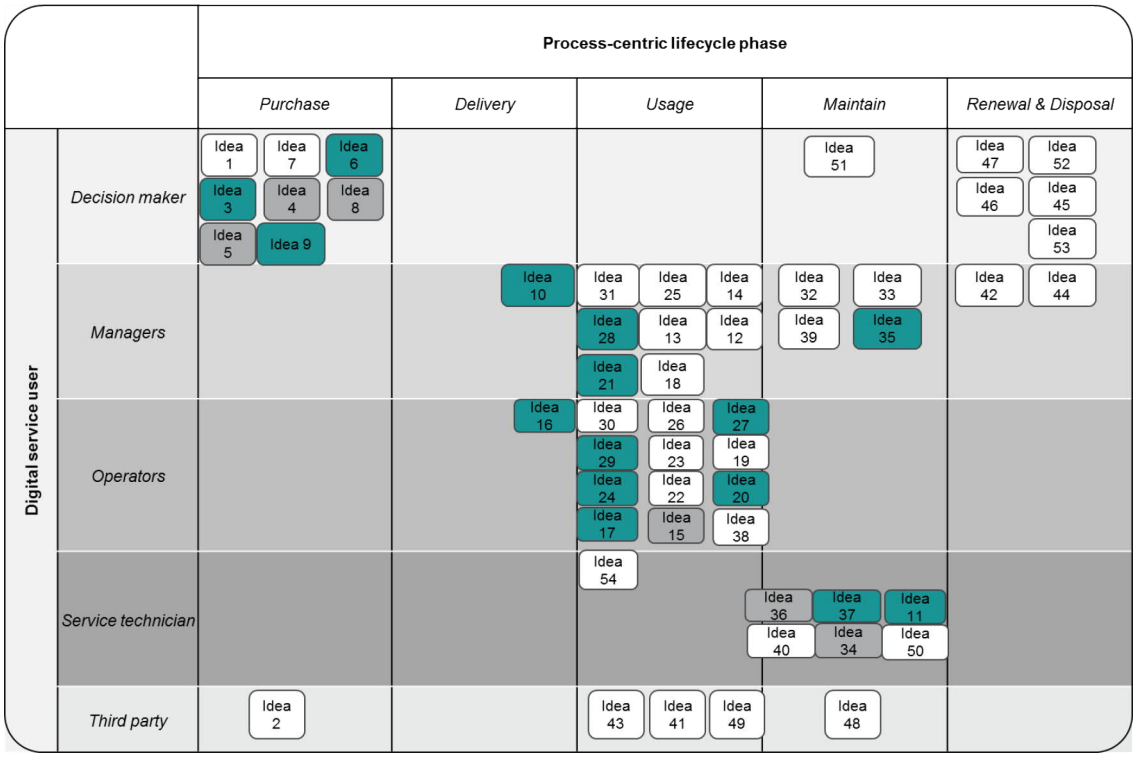

Figure 4.9: Digital service idea concepts arranged to the ideation framework.

As can be seen from the Figure 4.9, the ideation framework is useful for presenting created digital service ideas, but it does not provide many details regarding the nature of digital services itself. Identifying strategic digital service classes begun by mapping the

digital service idea concepts based on the digital service relation to physical core offering and the customer stakeholder. The second classification then utilizes findings by Chowdhury (2015) (main classes of digital services). The digital service idea concepts illustrated in Figure 4.10 are arranged based on their dependence of the physical device and roughly to indicate the primary user.

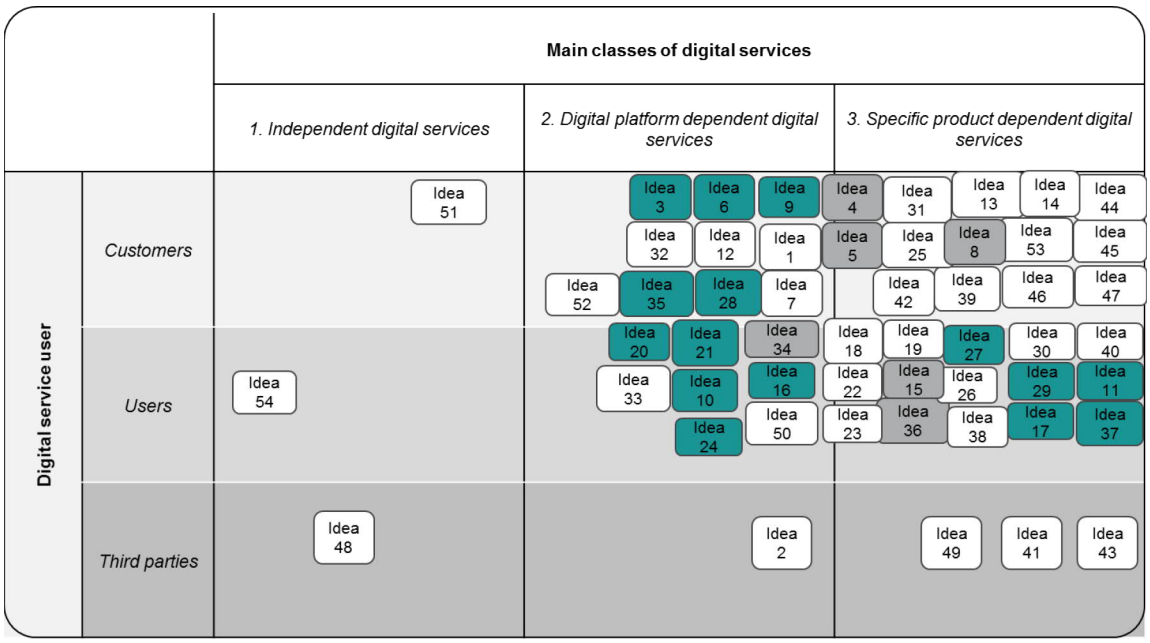

Figure 4.10: Idea concepts relative dependence of physical equipment.

Digital service idea concepts could be classified based on loose framework illustrated in Figure 4.10. However, the classes still would not tell much of the idea concepts nature or core concepts. The framework in Figure 4.10 helps to identify, which digital service ideas relate to physical equipment.

Following the objectives of the current study, the researcher pooled 51, 54 and 48 to their group and continued to classify rest of the ideas based on their core. Therefore, the researcher included only those digital service ideas which have a connection to the physical offering to strategic digital service classes. Digital service portfolio presented in Figure 4.11 summarizes top-level digital service idea classes for the case company, which are explained further after the portfolio. Classes, which the final digital service concept represented most are highlighted with grey, and classes which the case company employees saw as important areas for development actions in future, are light blue.

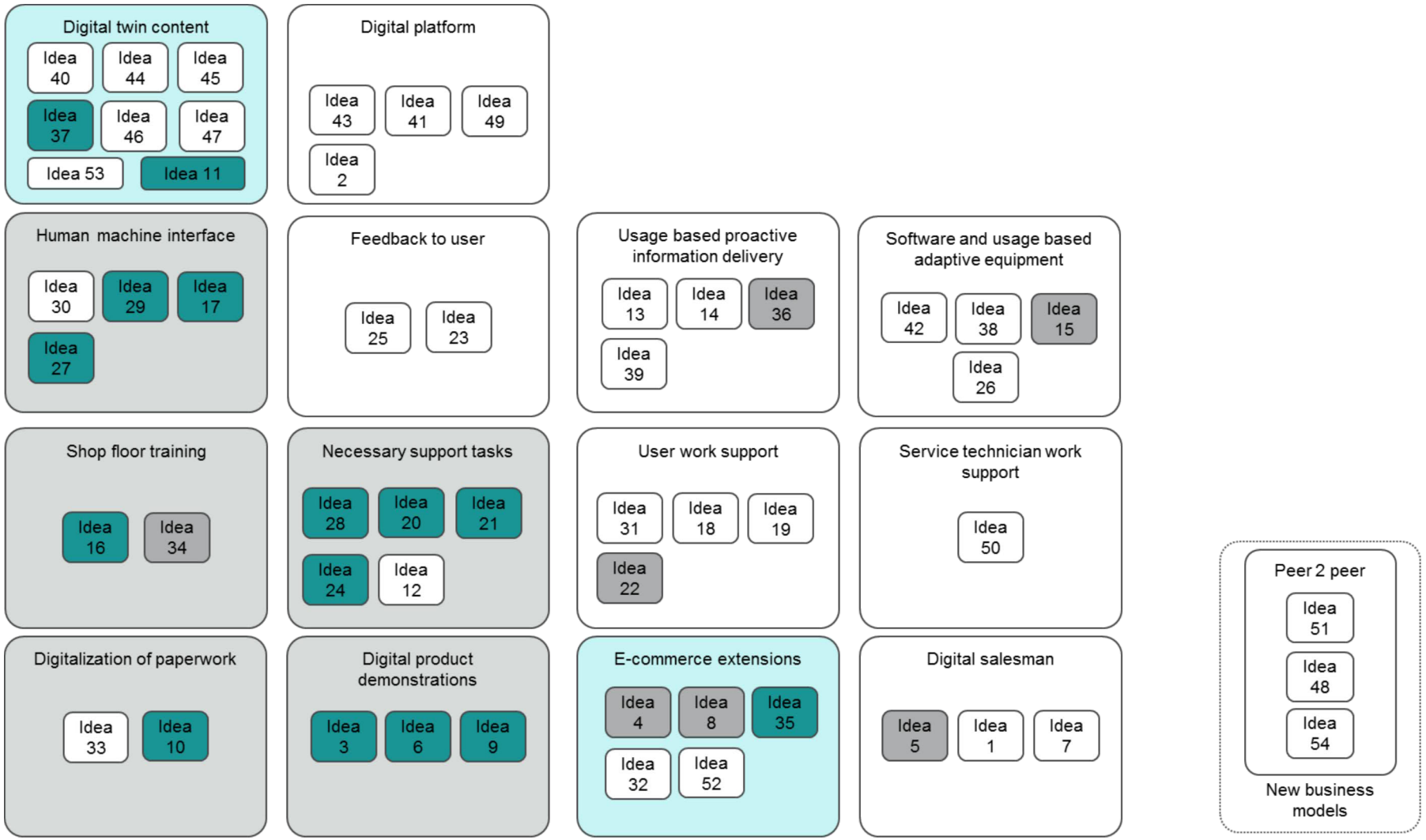

Figure 4.11: Digital service idea concept portfolio.

The digital service portfolio consists 15 separate classes, which the researcher identified based on the content of the ideas and the result presentation interviews. *Peer 2 peer* ideas relate how the case company should facilitate exchange between third parties, which does not directly link to physical equipment. Also, while conducting the classification, a new term came up from the ideas, *digital twin,* which is defined next. Digital twin in the case company is a digital representation of an individual piece of equipment delivered to the customer, which allows the case company to make business related decisions (e.g. to decide when service actions are needed). The case company understanding of digital twin is similar to General Electric's definition (General Electric):

"A digital twin is a dynamic digital representation of an industrial asset, which enables companies to better understand and predict the performance of their machines and find new revenue streams, and change the way their business operates."

The remaining 14 classes are elaborated further next. *Digitalization of paperwork* means digitalization of all documents, which are related to equipment purchasing, delivery and the equipment itself. *Digital product demonstrations* are different kinds of visualizations of equipment, which help the customer to familiarize the product prior purchasing decision. *E-commerce extensions* mean digital service ideas, which extend and upgrade the case company's digital sales channel. *Digital salesman* category encompasses digital service ideas, which demonstrates the value of equipment in various ways. *Shop floor training* means digital services, which shop floor workers can utilize to train the use and service of the equipment. *Necessary support tasks* are digital services, which makes relatively frequent tasks related to equipment smoother and easier. *User work support* and *service technician work support* classes encompass digital services, which makes their work easier and enhances the quality of their work. *Human machine interface* digital service ideas bring new functionalities and information to people around the equipment by the new interface, for example with the help of users smartphone or augmented reality glasses. *User feedback* digital service ideas relate how the equipment gives feedback to the user and suggest them to correct their actions. *Usage based proactive information delivery* means ideas, which suggests that the digital service would proactively deliver the right information to the right user at the right moment. *Software and usage based adaptive equipment* digital services are highly advanced ideas, which means that the digital service would, in fact, make the equipment proactively to adapt current situation and its surroundings through learning. *Digital twin content* digital service ideas relate to what content the digital twin should encompass. Finally, *digital platform* related ideas describe what kind of digital service the case company should offer to create a platform for their own and competitor's equipment.

4.3 Strategic opportunities

It was clear that the case company employees saw a great opportunity and a business need to create digital service for their equipment offering. When the facilitator raised the topic

at the beginning of the first workshop by asking *"Why are we innovating digital services?"*, the participants were thinking, for example, the innovation opportunities from the digital technology as well the need to be first in the market. More than anything, the business need was evident.

"We won't survive if we deliver just steel. Profit from our products will decline if we won't do anything. Digital services will allow us to increase our profit margin, and we have this responsibility to our investors."

Digital services delivered along equipment offering yield differentiative competitive advantage, which justify the higher price on the marketplace can enhance the case company's profitability. Without exception, both in workshops, benchmarking interviews and in result interviews, differentiation was argued to be the main competitive advantage that the digital services offer.

4.3.1 Competitive advantages

In the case company's IMS employees were suggesting the creation of digital services already six years ago. However, it very well might have been that customers and users would not have been ready to adopt these new kinds of offerings then. Even though the topic had been on idea level for a long time, the workshop participants still saw an opportunity to differentiate from the competition:

"This is an opportunity to create a new type of differentiation."

The same conclusion was easy to do in Hannover Messe when benchmarking digital service ideas. For example, AirComp C had a digital service, which allowed the user to start the compressor and change its pressure remotely using their smartphone. As such, the digital service is not too complicated, but the sales engineer said that so far test customers and users love it. They just officially launched it, and he was sure that the digital service would differentiate their offering from the competition.

It seems that the case company has an opportunity to realize a fast win now with their conceptualized digital service offering, which was identified to play a crucial role regarding having the approval to move the concept to development. Digital service development has to be started from the low hanging fruits to start to build competence. The case company's business designer concluded well, why the business need should be fulfilled fast and not worry too much how advanced the concept is.

"People keep talking that we need to create a new e-mail. However, there would not be e-mail without that somebody created a fax machine. We need to come up a new fax."

Most of the conceptualized idea concepts were related to digitalization of paperwork, digital product demonstrations, shop floor training, necessary support tasks and human

machine interface classes. Digital service offering encompassing these elements is expected to create a competitive advantage for the case company today and at least slightly differentiate its equipment offering from the competition.

4.3.2 Future business potential

The future business potential is defined to be strategic opportunities, which the case company identifies to offer a competitive advantage in future. The researcher identified that the case company has three types of digital service opportunities, which create future business potential. First, there are digital service idea concepts, which create capabilities. These ideas relate to integrating the people tightly to the digital service offering as well integrating the digital service to the equipment offering. These opportunities are ideas relating to digital twin content and e-commerce extensions.

Secondly, the case company employees saw that even the first ideas they selected to development today, has great potential to enhance customer loyalty and increase the customer relationship. They selected ideas, which are aiming to solve common, everyday problems from customer's manager, users and service technicians. Since it is assumed, that these stakeholders would use the digital service offering, they are constantly more tempted to seek help also for traditional service tasks from the case company. Therefore, the concepts which create competitive advantage today for equipment offering, are evaluated to yield future business potential from traditional service activities.

If the case company develops their capabilities, they make further development of digital service offering integrating equipment user, the digital service, and the physical equipment possible, which is the third cluster of opportunities for future business potential. Those ideas, which belong to user work support, service technician work support, user feedback, usage based proactive information delivery, software and usage based adaptive equipment and digital platform yield opportunities, which are still today difficult to pursue successfully, which the executive vice president of the case company did conclude very well.

"It would make a change if we bring more decision-making capabilities and have an equipment offering, which adapts to its situation and user from software. Still, we have not done this before, and we need to start learning with simple concepts."

The case company is today lacking capabilities to develop advanced digital service idea concepts, and the market might not be ready for them. Once the case company has leveraged the competitive advantages, it should invest in future by ensuring that the needed capabilities are ready when the market is. After all, the benchmarking indicated that industrial customers and users seem to appreciate these user-centric digital services, which shows that the potential is there. For example, product manager in AirComp B said that

they had no choice but to try, what customers feel about augmented reality remote support for service, which they include in all their flagship equipment offerings.

"Nobody has delivered smart glasses along with their compressor's before. We need to try. So far customers like it, and it has differentiated us from the competition."

The case company employees saw potential lock-in of the customer as the largest opportunity and threat. If somebody else solves customers' problems before the case company has a digital service for the same need, it will be much harder to convince the customer to replace the solution, and hard to sell equipment, which does not work with their existing solution. Therefore, the evaluation of future business potential becomes difficult. If one assesses only what would be the direct competitive advantage, that the digital service concept creates, they might not consider all factors. It hard to see, how customer's decision-making might change, once user-centric digital services become common.

4.4 Suggested development roadmap

Based on the identified digital service classes, it is possible to construct a roadmap for digital service development. The roadmap dimensions were identified based on the notes that the researcher made from the result presentations, where the interviewees repeatedly brought up two themes. The themes were; how deeply to integrate the digital to the equipment, and how much the digital service interact with the people (i.e. the users of the digital service). Finally, the innovation manager and the researcher carefully assessed what is truly the value of the digital services, and the case company innovation manager simply noted:

"Connecting people and the [equipment]."

The digital service then is connected to the physical equipment and the people using the equipment. More advanced digital service idea concepts require more integration and were evaluated to be less feasible today.

The researcher proceeded to place the dimensions and then identified five strategic phases that the case company could take to realize the future business potential. An additional opportunity for the case company is to facilitate the exchange of digital and physical goods and service between third parties and peers (customers). This opportunity, as well other *new business models* which digital services enable, does not fit into the scope of this study, which is why it is not on the roadmap. The roadmap presented in Figure 4.12 is constructed based on interviews after result presentations and the researcher's analysis of the created digital service idea concepts.

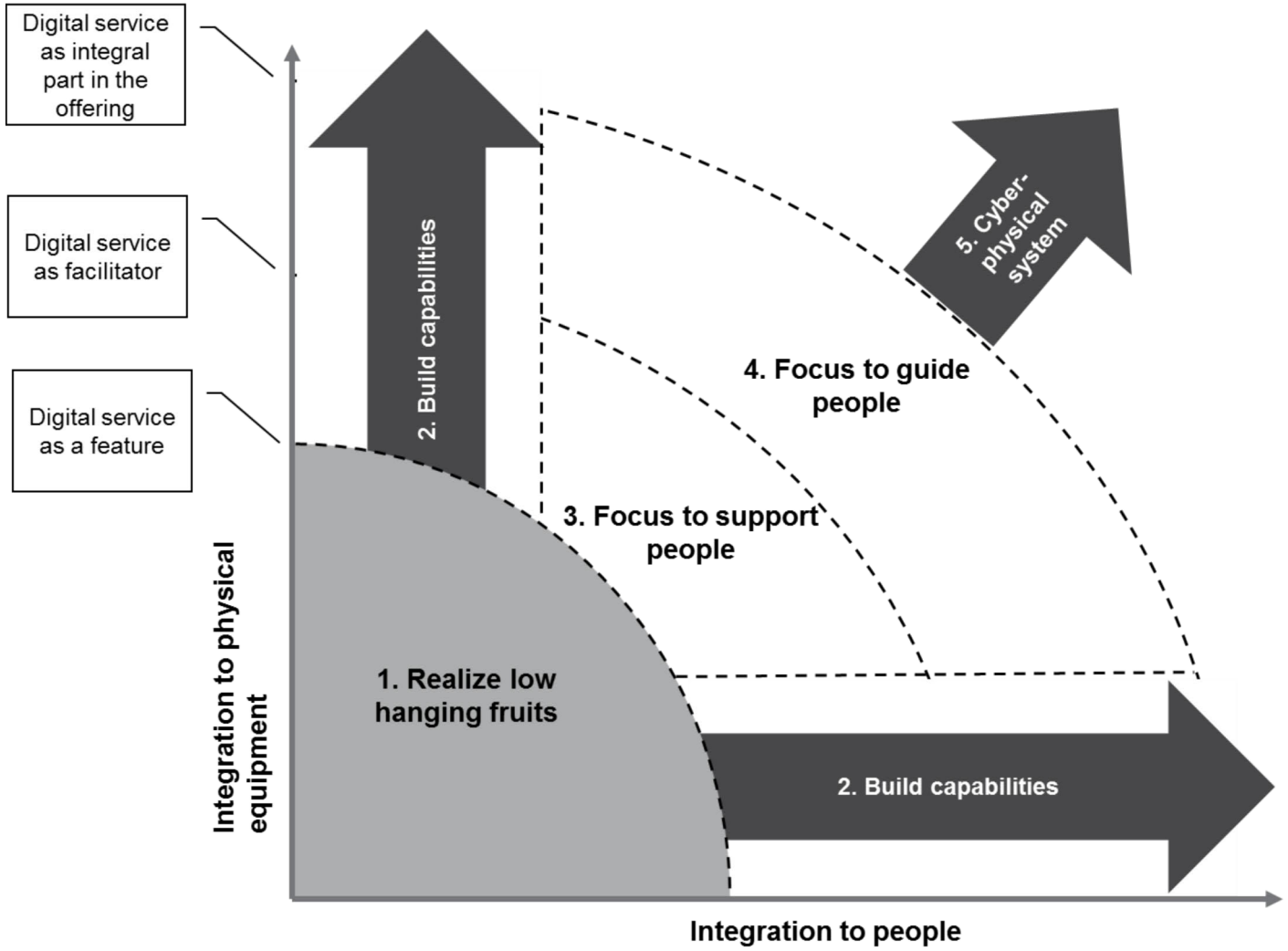

Figure 4.12: Strategic digital service development roadmap for the case company.

Digital service ***realization*** is the start of the case company's journey. They have an opportunity to connect their equipment to people with relatively straightforward and feasible digital service offering, which still today creates competitive advantage. Digital service idea concept selected to be conceptualized mainly represented opportunities, which belong to digitalization of paperwork, digital product demonstrations, shop floor training and necessary support tasks. At this point, digital service is more of a feature, or an extension, delivered along equipment offering.

The second phase is to build ***capabilities***. More advanced digital service requires extensions to the case company e-commerce platform, and a creation of a digital twin from each equipment delivery. These capabilities make possible for the case company to harness the future business potential, which is already partly realized by building the capabilities. Here the company needs also to refine and adapt more agile development methods and truly embrace user-centric service development, but remain market rather customer driven.

The third phase is to ***support the people*** with digital service delivered along physical equipment. At this stage, the customer can purchase and configure the equipment by themselves or the salesman is only providing the human interaction to the sales situation. New equipment sales are made based on information available from a fleet of digital twins, from which the case company employees can assure their customers that their solution truly fits their needs. Also, users workflows are supported with the digital service offering, and service technicians can utilize many types of simulations at their tasks. At this point, the digital service offering acts as a facilitator for the people around the equipment.

Then, the fourth phase is to integrate usage data and ***guide the people***, which increases human machine collaboration by utilizing real-time and historical data from the equipment. The digital service is capable of providing feedback to the user based on their usage patterns. Also, service technician work is almost entirely planned automatically, reducing maintenance time. Digital service makes it possible for the customer to configure their equipment capabilities flexibly and utilize simulations and augmentations to select the best configuration for their need, which is suggested to them by the digital service. Equipment has a reliable two-way connection to user's digital technology, which extends the collaboration even further.

Finally, the fifth phase is to create a ***cyber-physical system***, where the distinction between digital service offering and the physical equipment is impossible to make and the digital service changes and affect the physical design of the core offering. Digital service, which connects the equipment to the user, delivers proactively context-sensitive information and is capable of making the equipment adapt to the user and the situation. A large portion of the value proposition is capabilities delivered as digital services, which allows the equipment to adapt and learn from its environment.

5. DISCUSSION

This chapter begins by summarizing the most important findings of this research by answering the presented research questions. After this, the chapter discusses the scientific contribution of this research, which the contribution for the case company follows. Finally, the chapter evaluates the results of this thesis.

5.1 Answering research questions

The overall objective of this study was to identify digital service opportunities for the case company. In the more detailed level, the objectives included creating a framework for digital service idea concept creation, finding a structure for digital service idea concept portfolio, identify strategic digital service opportunities and finally, suggest a development roadmap for the case company. Research problem and the reason to conduct this study is that identification of user-centric industrial digital service opportunities had not studied in the academic literature, and practical use cases which the case company could follow, are still rare.

The empirical section of this research employed multi-method approach, which consisted reviewing documented information, observations and semi-structured interviews from which the objectives of this study guided to emphasize observations. The main focus was to refine and formulate front end phases of digital service innovation, ideation method for industrial digital services and then identify what digital service opportunities the case company has. Existing scientific literature provided foundations for the empirical examination which results of this study extended and refined using qualitative data analysis process. In total, the empirical data consisted over 200 raw ideas and 54 idea concepts, hours of observations and dozens of pages of notes from all front end of innovation phases as well from the two workshops. Finally, the researcher interviewed the case company's decision makers, and the benchmark industry representatives to deepen the perspective, which was required to identify digital service opportunities for the case company. The research problem and objectives of this study guided the formulation of the research questions, from which this chapter answers to the sub-questions first.

1. *How can the company create digital service idea concepts for the whole life-cycle of their equipment offering?*

The first important finding of this research is the overall structure of the front end of digital service innovation, which utilized work done by Frishammar et al. (2016). Refined front end of digital service innovation process together with the digital service ideation framework entails the core physical equipment as well makes sure that customer and user problems are used to prioritize the progress. Indeed, the identified front end of digital

service innovation reduces the uncertainty for digital service idea concept creation, but keep the process agile.

The created digital service ideation framework captures the lifecycle centered approach to digital service innovation. When the case company uses the framework, it considers the entire lifecycle of an offering from customer's perspective with correct profiling of relevant stakeholders. The digital service ideation framework follows Aurich et al. (2007) example and adds to the model practical user-centricity from design thinking practice (e.g. Liedtka 2015). The case company employees created most of the digital service ideas in beginning of the lifecycle for the customer's decision makers, during the operational phase for the user and the maintenance for the service technician, which the results in the chapter 4.2.2 illustrate. This creates a temptation to streamline the ideation framework to encompass only the most common stakeholder for each stage, but that is a too large simplification. When digital technology advances, who knows, maybe in future equipment users are the ones making purchasing decisions, which would convert Abrell et al. (2016) findings around. When the ideation phase entails equipment lifecycle as a whole and all stakeholders, the case company can be sure that they truly innovate digital create concepts for the entire lifecycle of their equipment offering. The starting point can be process-centric equipment lifecycle by Hastings (2010), which following suggestions by Aurich et al. (2007), needs to be refined to fit specific physical equipment.

Results also show that finding ideas by benchmarking does not yet yield too many discoveries, due to the novelty of the research area. Industrial digital service offering has not yet developed to the point that it would be sufficient to scout best practices. Therefore, a proactive approach is required, and the case company can utilize their IMS to verify and find customer and user insights. The insights can be problems worth to solve and new opportunities. In a sense, a well over 100 case company's employees contributed indirectly to digital service idea concept creation, which compliments Woisetschlger et al. (2016) findings. Without this channel, it would require much more effort to gather such an amount of ideas and insights from their industry. Utilization of customer and user insights in digital service idea concept creation is critical.

2. *How can the company take characteristics of their industrial equipment offering into account in digital service innovation?*

Industrial equipment offerings have two main characteristics, which has a fundamental effect on the front end of digital service innovation. First, industrial equipment lifecycle is long, and secondly, during this time multiple different stakeholders interact with the equipment as found from asset lifecycle management literature (Hastings 2010) and from the innovation literature (Abrell et al. 2016). These characteristics were identified both in literature and confirmed in the empirical part of this research. Also, those who decide to purchase the equipment, are not those who use the asset.

Different stakeholders in industrial customer even further emphasize that front end of digital service innovation should adopt the user-centric approach. It is critical to encompass all these stakeholders, which pushes practical arrangement in digital service innovation process towards design thinking methodology (e.g. Liedtka 2015; Abrell et al. 2016).

The digital service ideation framework was refined from Aurich et al. (2007) service ideation matrix, which takes into account the most relevant characteristics of their equipment offering into account. The framework guides the case company's employees, who are working on digital services, to focus on all lifecycle stages as well to all relevant stakeholders. To conclude, the case company can take characteristics of their industrial equipment offering into account by first defining the core physical offering and then identifying stakeholders who are interacting with the equipment.

3. *How can the company evaluate the impact of digital service to competitiveness to their equipment offering?*

Based on the extant literature of hybrid-offerings (e.g. Ulaga & Reinartz 2011; Eggert et al. 2015), digital service delivered along physical equipment does have potential to create competitive advantages through differentiation, cost leadership, and customer satisfaction. Findings from empirical part of this research directed to evaluate differentiation and customer satisfaction by evaluating customer and user value. Therefore, to evaluate the impact of digital service to the competitiveness of their equipment offering, the digital service idea concepts should be evaluated by how much it creates customer and user value. Size of the problem that the digital service solves from its user and the customer determines the customer and user value. After conceptualizing the digital service ideas, the case company should be put them to the test and learn, if the customer and user value the solutions to their problems. The process follows closely design thinking practices as well findings by Frishammar et al. (2016).

Customer and user problem orientation is crucial. If intangible digital service leaves unused, it most likely does not create any value for the customer nor the case company. Also, if the digital service does not solve any of the user's problems, it is highly unlikely that somebody uses the offering, even if the customers would get it for free. To conclude, the case company can evaluate the impact of digital service to the competitiveness of their equipment offering by evaluating how big of a problem it solves from their customers and users. Once the case company can utilize customer and user interactions, they should become the primary judge to assess if the digital service concept can create any value and solves their problems.

RQ: "How can the company identify digital service opportunities to enhance the competitiveness of their industrial equipment offering?"

In addition to sub-questions, the overall research question requires the use of the strategic classes of digital services, i.e. digital service idea concept portfolio. After all, strategic opportunities in the front end of innovation are concepts, which have been evaluated to bring competitive advantage and future business potential (Martinsuo & Poskela 2011). The digital service idea concept portfolio presents opportunities to enhance the competitiveness of the case company equipment offering by bundling intangible digital features to the product. Now, when digital service opportunities are better defined, and their role is clearer, systematic opportunity identification for digital services is possible in the first place. Previous scientific literature had identified digital service opportunities from supporting technical customer service (e.g. Legner et al. 2016; Fellmann et al. 2013), widening remote service portfolio (e.g. Brax & Jonsson 2009; Grubic & Peppard 2016), but indeed, there are opportunities to utilize digital service to enhance equipment competitiveness.

The case company can utilize the identified front end of the digital service innovation process to reduce uncertainty while creating the digital service idea concepts to be evaluated and placed in the portfolio. By re-evaluating the created digital service idea concepts, it is possible to follow when the timing is right to move to towards more advanced digital service offering. As the digital technology advances, idea concepts which are today unfeasible will become within reach of the case company. At the best case, digital service development would lead the market and constantly capture early adopter's latent needs. Therefore, when the last phase of the front end of digital service innovation validates the important assumptions, it is possible to determine if the concepts are creating competitive advantage, future business potential, should the concept be further refined or dropped.

The findings suggest that the case company should adopt increasingly agile innovation processes in future. Identifying digital service opportunities, which enhances the competitiveness of the equipment offering, is an iterative process, which requires that the case company gather customer and user insights, then proactively create digital service concepts, puts them to the test and uses new insights to refine digital service concepts further.

5.2 Scientific contribution

The main scientific contribution of this research is to refine ideation methodology for industrial digital services and provide insights, how front end of digital service innovation happens in industrial context. Also, this study found how digital service enhances the competitiveness of industrial equipment offering. The research has, therefore, met the scientific goal set in Chapter 1.2, and address the research gap found in existing literature. Opportunity identification for industrial digital services in an industrial context is still

widely unexplored in academia when defining digital services as user-centric digital features delivered along an equipment offering. Up today, scientific literature has lacked empirical research of front end of digital service innovation conducted in an industrial context. This chapter is organized first to elaborate scientific contribution to ideation literature. After this, the chapter discusses the identified front end of digital service innovation as well the competitiveness, which digital service creates by solving user problem along with an equipment lifecycle.

Industrial digital service ideation

By the knowledge of the author, this research was first one to combine process-centric lifecycle approach to user-centric ideation in the front end of digital service innovation. This was done by refining service ideation matrix developed by Aurich et al. (2007) towards practical design thinking methodology summarized by Liedtka (2015). First, the refinement was carried out based on findings by Abrell et al. (2016), as they suggested that there is a need to distinct industrial customers and end users of the equipment in digital innovation. In empirical section of this study it became clear that during the equipment lifecycle, there are many types of shop floor workers and different kinds of decision makers, which should be considered. Indeed, the case company's customer consists decision makers, managers, users and service technicians. By dividing the equipment lifecycle and customer, the ideation becomes more targeted rather than generic, which again contributes to the creation of specific idea concepts and finally more defined the overall concept.

Results of this study support also Abbrell et al. (2016) findings, which further suggest that manufacturing companies need user and customer knowledge in the front end of digital service innovation. However, Abrell et al. (2016) view to customer stakeholder has to be broadened and further defined – it is not enough to identify user and customer. Instead, all relevant roles within the customer are necessary to address, which means that digital innovation in industrial context goes far beyond usage and purchasing of equipment. Still, the findings support that manufacturing companies have to find methods to gain detailed customer and user insights. It is crucial to identify who is the user to create successful digital service innovations. This way it is possible to assess how the digital service delivered along the equipment helps this person to accomplish their tasks and solve their problems.

Also, the employed methods to analyze created ideas are new for prior literature. Chowdhury (2015) finding of digital service relation to the physical device was employed to identify digital service opportunities, which the case company should deliver along with their equipment offering. Also, by mapping created digital service idea concepts to the ideation framework it was possible to see how the workshop participants created a large number of digital service idea concept for shop floor workers, which further stressed the importance of this stakeholder. Indeed, managing digital service innovation is also portfolio management, and this research has provided one set of tools to do that.

The analysis of existing ideas from the case company's IMS supports Abrell et al. (2016) finding that it is easier for an industrial company to gain customer knowledge than user knowledge for digital innovation. This is because the most active employee type to submit digital service ideas are managers, which supports Woisetschlger et al. (2016) findings. Front-line managers listen to the customers, and by doing so, are fishing ideas. Managers interact with customers, gather their decision maker's suggestions, listen to their insights and translate these notions into defined customer problems which could new digital services could solve. When the managers have a channel to submit and disperse their insights, ideas were possible to use by the case company. If this IMS would not exist, the case company would not have the possibility to revisit to ideas, which were ahead of their time, and would have lost much of the potential. Acquiring user knowledge is indeed more difficult since the interaction with equipment users and customers service technicians requires site visits. Also, feedback meetings with customer's users nor service technicians are rarely arranged along frontline work.

Digital service innovation

Digital service innovation requires clear and compelling business reason, which should guide the overall front end process. Still, the underlying focus should always be the user and customer problems. Otherwise, the digital service concept would not solve the user problems, which most likely means that the business reason is left unfulfilled. The overall description of front end phases in digital service innovation refines the radical concept creation process identified by Frishammar et al. (2016) towards design thinking approach. It seems that the case company, which has started to implement design thinking approaches, cannot directly embrace the practical models used in leading design companies summarized by Liedtka (2015).

Frishammar et al. (2016) found that the customer problem orientation in the Prime Group was one of the key success factors in their work which happened in the case company also. The reality of how the case company manages the overall innovation process shows that internal business reason should be the starting and driving force in the front end of digital service innovation. Once the business problem sets the direction, user and customer problems become the most important thing to fulfill. Also, the results from the analysis made for ideas found from the case company IMS suggests that customer and user insights found from the ideas can partly replace the vital customer interactions that Alam (2006) has identified to reduce uncertainty in the front end of service innovation. Indeed, the case company can improve the front end of digital service innovation by utilizing their active IMS.

The customer and user problem orientation, which should drive the creation and evaluation of digital service idea concepts, also clarifies how digital service innovations can enhance the competitiveness of an industrial equipment offering. The digital service can differentiate and increase the customer satisfaction when the total offering is aimed to

address wider need than the physical equipment alone, which means solving customer and user problems during an equipment lifecycle. It is known that when OEMs are supporting customer's operational processes with a traditional service offering, they can achieve a win-win situation (Grönroos & Helle 2012). Also, when customer need is fulfilled in more broader level, it should lead to increased customer satisfaction (Jaakkola & Hakanen 2013), which creates a competitive advantage for hybrid-offerings (Raja et al. 2013). Before this research, the scientific literature had not throughtly studied, how digital service delivered along an equipment offering could ease the customer's operational processes by supporting their stakeholder's tasks along the equipment lifecycle, which in practice has required a traditional service contract. As it seems that digital service can even draw external resources for value creation (Lusch & Nambisan 2015), the offering is therefore capable of addressing a wider need its components alone can.

The empirical part of this research did not gather customer and user assessment of digital service idea concepts, but still, it seems that the existing scientific literature is lacking knowledge how an entire segment of an industrial offering affect to equipment offering value proposition and competitiveness. Indeed, digital service which OEMs can deliver along with their equipment offering could mean that in the future industrial offering will address needs of a variety of stakeholders along the long equipment lifecycle.

Insights for future research

This research also provides insights for further research, as the findings suggest that there are great digital service opportunities between basic ICT-based services, remote monitoring, and digitally enhanced field service operations, which are user-centric digital services delivered along industrial equipment offering. Extant literature has mainly addressed mobile applications supporting manufacturing organizations own service processes (e.g. Fellmann et al. 2013), how remote services can be used to widen the service portfolio (e.g. Brax & Jonsson 2009; Grubic & Peppard 2016) or innovation opportunities which CPSs yield (e.g. Herterich et al. (2015a; 2015b; 2015c; 2016). It seems that industrial digital service can improve the competitiveness of core physical offering by creating new capabilities to equipment and supporting customer's and user's processes and tasks. Also, digital services yield future business potential for traditional technical customer service by connecting the customer and equipment manufacturer more tightly together.

Created digital service idea concept portfolio brings clarity to what in fact industrial digital services are as well extends and refines prior understanding of digital service opportunities. The portfolio contributes to bridging the gap between basic ICT-based services and the most advanced hybrid-offerings and provokes further academic attention to study user-centric digital services delivered along physical equipment. Lerch & Gotsch (2015) did identify these pure digital services in servitization – digitalization transformation, they

did not elaborate what these digital services are. For example, mobile applications supporting service technician tasks is only one fraction of the opportunities that the case company has.

It still should be remembered that these contributions are highly subjective and based on findings made in a single case study, from a single front end of the digital service innovation process. Since the addressed gap in the current academic literature is wide and the topic is constantly more relevant among industry practitioners, even these findings can be a starting point for future scientific research. Indeed, if the identified digital service opportunities are to create competitive advantages for the case company, there is an entire segment in an industrial offering, which is relatively unknown to academic literature today.

5.3 Contribution for the case company

Empirical part of this study identified digital service opportunities for one product platform offered by equipment business A. Now, the case company is exploring, what would be the digital service opportunities to other product platforms and for the equipment business B. The results of this study are likely to be applicable to other product platforms as well, which helps the case company to reduce uncertainty in the first phases of digital service development process.

The case company can follow the identified front end of digital service innovation, and therefore know what they need to do in each phase. The process still allows the digital service concept creation to be agile and customer oriented, without forcing the case company to go directly to observe customers without any assumptions to be validated. In the final front end phase, once the digital service concept is somewhat finished, the team needs to ask, “Do this solution fulfill our business reason?”, where they will identify two types of assumptions; assumptions related to customer and user problem and solution fit, and assumptions related to business reason and solution fit. Not having an answer to assumptions from either one of these groups might prevent that the decision makers allow developing the digital service concept further. This might not be the ideal way to work, but it seems to be the reality the case company.

The digital service ideation framework is a great tool when the case company has to create rapidly multiple raw ideas to entire equipment lifecycle and for all stakeholders. Also, the development template found from Appendix 3 forces the case company employees to assess what the essence of the idea is and what problems it solves. Table 5.1 summarizes the key contributions for the case company.

Table 5.1: Main contributions for the case company.

Result	Contribution
Front end of digital service innovation	To use for guide the digital service creation for other product platforms
Digital service ideation framework	To be used for ideation of digital services
Digital service idea concept portfolio	To be used for idea concept management and to provide common language
Identification of strategic opportunities	To use as a reference when making development decisions and project proposals
Suggested roadmap for digital service development	To use as a reference when making longer term planning

Some direct suggestions are possible to make for the case company based on this research. The first strong suggestion is to continue towards validating the created digital service concepts with customers as presented in Chapter 4.1. After this, the decision to start actual development work is somewhat straightforward to do – if some parts of the digital service concept are not needed, they can prioritize the work towards those, which create competitive potential today. It all comes down to speed – if the case company can realize the digital service concept fast enough, it may very well have time to build capabilities for more advanced digital service development in future. Therefore, relatively fast, proactive approach to the front end of digital service innovation is needed – it is important to learn which assumptions are true and which are false, to direct the innovation efforts towards the right opportunities. The development process has to be agile and iterative – customer and user interactions are necessary for the development process.

The results make possible to provide some longer-term suggestions, which relate to the case company's other product platforms. The case company should start to define a strategy for digital services. It still might be a bit early, since they do not have experience of development nor what is the impact of digital services to existing business, but still, it seems that defined strategy would make it easier to decide how much they should pursue future business potential and how much competitive potential today. While formulating the strategy, the case company's key employees should carry out the same kind of exercise to other product platforms with a diverse group of frontline employees. If the same digital service idea concepts come up, the case company's development team can seek synergies when creating the solutions. Figure 5.1 presents suggested longer term next steps for the case company.

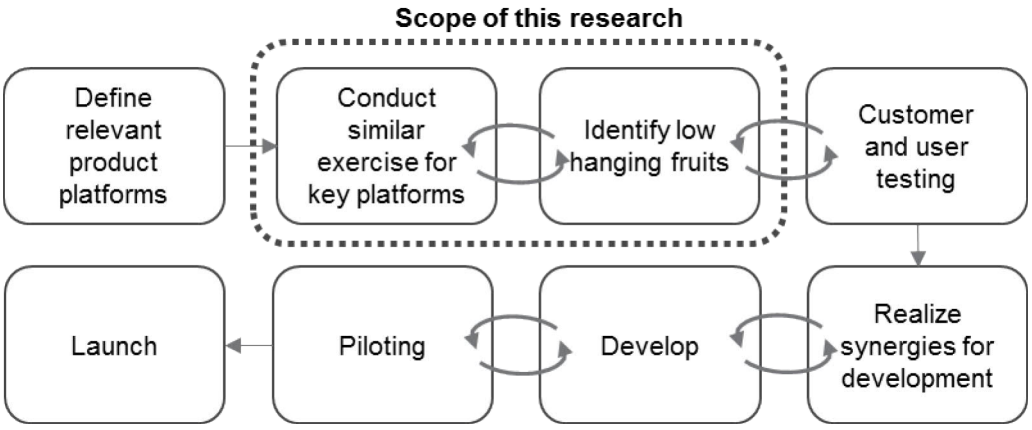

Figure 5.1: Suggested next steps for the case company.

Suggested next step is that the case company identify all relevant product platforms for digital services. From these relevant platforms, they need to identify key products, which represent the platform well enough and has individual customer segment. Once they have decided the product platforms; the case company should carry out a similar opportunity identification as done in empirical part of this research. After the low-hanging fruits are clear, it is possible to proceed to customer testing as the defined front end of digital service innovation in Chapter 4.1. suggests. The customer and user testing should validate the fit between digital service concept and problem, which is why next they can identify synergies between different digital service concepts for the key product platforms. It is highly likely, that the digital service concepts have similarities from the development perspective. Actual development work should be carried out using agile methods with tightly integrating pilot customers and users to avoid unnecessary extra work. To recap, the key suggestions are:

1) Define key product platforms which would benefit from digital service and ideate digital service concepts for them.
2) Validate digital service concepts with customers and equipment users.
3) Continue to identify low-hanging fruits, build needed capabilities and realize synergies for agile digital service development.

For the case company, this approach to pilot mock-up solutions with customers before a formal development project has started is quite a new approach. For the front end of digital service innovation, customer and user interactions are vital compared to traditional product development, which many times is done behind closed doors. Indeed, a good way to test the market is to offer customers and users porotypes to test, which is in line with design thinking best practices. The case company should carry out the front end of digital service innovation by loosely applying design thinking methodology, but to be careful from breaking too many "rules" of the incumbent organization overall innovation process.

The development roadmap provides the company a viewpoint, why digital service development has to start from simple low-hanging digital service idea concepts and continue

to build capabilities as soon as possible during 2018. The case company has to create digital twins of their equipment deliveries and create e-commerce channels, which support aftersales of digital services, at best before 2019. The digital twins are needed to create the content for more advanced digital service offering, which the case company can express and distribute using e-commerce extensions and digital salesman. Integration to the equipment is needed to develop digital service offering, which solves the problems that are visible in the digital twins, but hard to discover by observing the customer and users. Indeed, by integrating the digital service to the equipment, the case company gets an ultimate source to discover latent user and customer needs. The user and customer insights can first be used to create digital service focusing on supporting the people, and later when wearable digital technology becomes common, to guide the users. Finally, the case company could consider developing a future industrial offering, which physical design and digital service have been integrated from the very beginning. Figure 5.2 illustrates the rough outline of digital service development plan for the case company.

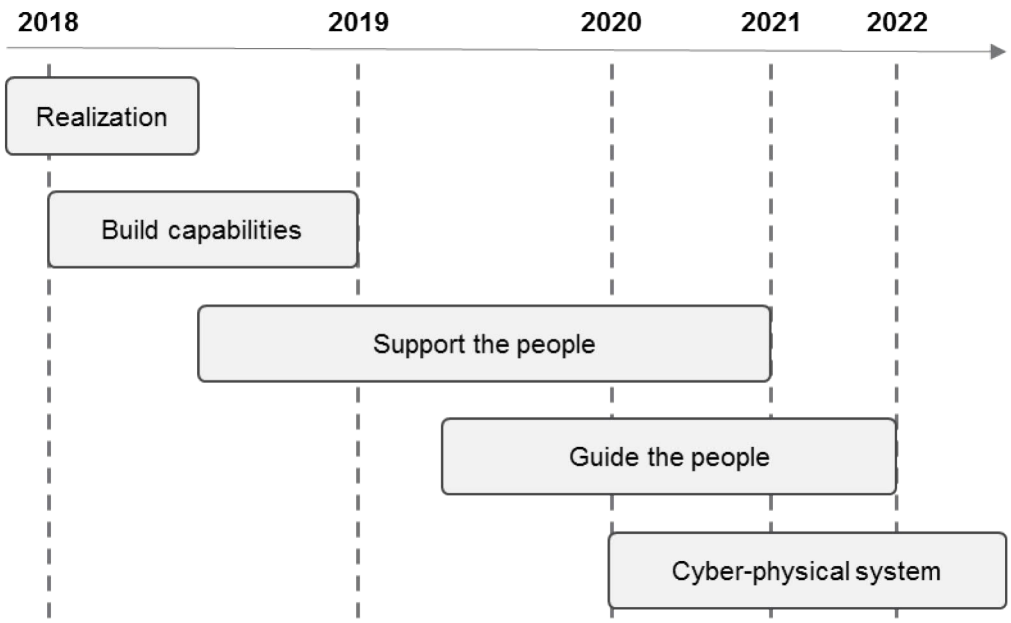

Figure 5.2: Outline of long-term development plan for the case company.

Development suggestions, which focus to the digital service idea concept level were confidential. Also, the lack of customer and user insights does not allow to refine the high-level development roadmap to more detailed one, which would provide digital service idea class development plan from the digital service portfolio.

To conclude suggestions regarding opportunity identification for industrial digital services bundled together with case company's equipment offering, firstly the case company should focus to realize digital services which are easy to implement and this way leverage competitive advantages. Secondly, the case company should build capabilities to leverage the future business potential. However, speed is important. The first step is nothing that their competitors cannot do. In the interviews, it became apparent that even a small start-

up companies can pick the low hanging fruits and start executing. Also, the case company's direct competitors can also build capabilities to integrate the digital service to people or focus on creating digital service offering tightly integrated with the equipment. The highest future business potential is to create digital services, which integrate both the people and the physical equipment. These digital services require both customer and user knowledge, but also technical knowledge how the digital service works with the equipment offering. After this, the case company can begin to realize strategic opportunities, which connect the digital service user, the case company and the homogenized digital data to the physical equipment.

5.4 Evaluation of results

Chapter 5.1 summarized findings of this research by answering to presented research questions, which in general are in line with the extant scientific literature, which the Chapter 5.2 discussed. From a practical perspective, the identified front end of digital service innovation does bring clarity to front end phases of development, and the ideation framework has been proven to be useful as well easy to understand. The case company uses the ideation framework for other product platforms and the identified front end of digital service innovation as a guideline for overall digital service concept creation.

Ideation framework has been proved to be the most usable result for the case company from this thesis. The team responsible for the development of digital solutions has decided to use the methodology for creating first digital service idea concepts and mapping the digital service opportunities for other product platforms. While they carry out this work, they plan to utilize the identified front end of digital service innovation to bring common language between business responsibilities and support functions. Also, the case company sees the digital service idea concept portfolio as a good starting point for managing digital service development and innovation, but it might need some modifications once they identify digital service opportunities for other product platforms. One weakness of the results is that the digital service idea concept portfolio might not last time – it might be that ideas that the case company creates for other product platforms do not fit to the portfolio dimensions. It very well could be that new idea concepts require adding new digital service classes to the portfolio.

Still, given that the objectives of this thesis were to define a framework for digital service idea concept creation, create a digital service idea concept portfolio, identify strategic digital service opportunities and suggest a development roadmap for the case company, it is easy to conclude that the results meet the objectives. From a scientific point of view, this research did successfully address the gap found in existing literature by introducing a usable methodology to identify digital service opportunities and adds to existing ideation literature by introducing a framework for industrial digital service idea creation.

It would have been ideal to incorporate customer and user interactions to this research. The case company did assess the digital service idea concepts from customer and user perspective, but it was the case company employees performed the evaluation. Now the assessment of digital service concept competitive potential is somewhat subjective as it is based on the case company employee's perception of customer and user needs and problems.

Indeed, the greatest weakness of the results is related to how the case company can evaluate the impact of digital service to the competitiveness of their equipment offering. This research did benchmark the digital service idea concepts, but it is still too early to tell if the competitiveness of their offering is improved. All interviews supported that digital service delivered along equipment offering will be at least nice to have, but only the lacking customer and user interaction can truly tell if digital service improves the competitiveness by solving their problems and create a better value proposition. The empirical part of this research did not continue to the last phase of the front end of digital service innovation, which would have tested the assumptions and validates the digital service concept. In a sense, yes, the research provides an answer generically: the case company needs to test the digital service concepts with their customers and users. However, to verify if the approach is suitable, the study should have continued until the end of 2017 – the scope and timetable of this thesis had a negative effect on the results from case company perspective. In addition, found strategic opportunities and the suggested development roadmap are providing only relatively high-level guidance. Without customer and user interactions it is not possible to bring more detailed roadmap. Since this research was not able to continue all the way to concept validation phase, the overall front end of innovation might still entail some turns which the results were not able to into account.

The results of this thesis are also highly case sensitive, as this is a qualitative single case study conducted by gathering data from one front end project. The study did not measure that how much front end of innovation and ideation has in fact improved by the impact of the results and how much due to the experience that the key employees gained in this process, was not measured because it was not possible to arrange an extra round of interviews. The chosen action-analytical research approach, as well the research methods, prevents from generalizing the findings to other companies. The results need to be considered subjective even within the case company, as they continue to develop digital service offering to other product platforms, which further suggests that the research has not built a new theory. Still, this was never the objective of the study, and the choices made along the way were made only to meet the given objectives and answer to presented research questions. Therefore, the overall results of this research can be considered good.

6. CONCLUSIONS

The final chapter of this thesis presents the conclusions of this research. First, it draws general conclusions of the research. After this, the chapter evaluates the overall research and finally suggests some themes for further scientific research.

6.1 Conclusions of the research

Opportunity identification for digital services is increasingly important for companies manufacturing industrial goods since it is difficult to increase the profits from selling steel and hardware. Digital service use cases in industrial context and extant literature are still sparse, and lack of existing knowledge was the reason why the case company saw necessary to conduct this research. The findings of this research (i.e. the framework for digital service idea concept creation and overall front end of digital service innovation, digital service idea concept portfolio, the strategic digital service opportunities and the development roadmap) can help the case company to find new opportunities in future and direct the development efforts as effectively as possible in near future. Now the case company has common language regarding the user-centric digital services and an extensive idea concept portfolio from which they can choose which opportunities to pursue.

The results of this research give more reasons for the case company to begin customer testing for digital service concepts as well to continue exploring digital service opportunities for other product platforms. Also, high-quality academic research is needed to fully understand what user-centric digital services delivered along physical products are, and to facilitate further digital service opportunity identification for industry practitioners. After all, the interviewed industry practitioners saw digital services as a way to enhance the competitiveness of their offering through differentiation. It is yet to see if and when the case company, introduces the digital services to the market, and if the market accepts their offering. Still, the results of this study make it reasonable to expect, that an offering consisting both physical core and intangible digital service is more profitable than either one alone for the case company.

6.2 Evaluation of the research

There were limitations in current research, namely that the front end phases of digital service creation were followed only in one case company, and the results were found data gathered from a single front end project. Also, since it was not possible to include concept validation with customers and users to the scope, the evaluation of digital service concepts

was not carried out in an ideal way. Therefore, findings of this study leave room for arguing if digital service delivered along the case company's equipment offering truly improves its competitiveness in the market.

Based on the literature review, the novelty of the research is high. It was somewhat surprising that existing scientific literature does not address the topic in an industrial context. Of course, it might also be that it is still hard to find existing literature due to lack to of generally accepted definitions to describe user-centric digital services delivered along industrial equipment offering. Therefore, it is somewhat easy to argue that literature review of this study have not fully captured state of the art. This research still does refine and extend current understanding of industrial digital service opportunities and did create new knowledge on top of theoretical foundations synthesized from existing scientific literature. Therefore, this study does meet the purpose of scientific research, which is to create new or extend existing knowledge.

A valid study is conducted to answer to presented research questions in the scientifically accepted way, and the validity is measured by assessing how well the research is measuring exactly what the study is supposed to measure (Olkkonen 1994). Current research constructs validity by defining key concepts, such as competitiveness and future business potential, based on existing literature. Also, from multi-methods observations were emphasized, so the researcher got a better view of the case company. The researcher was involved in the empirical section of the study and had good access to see how the digital service opportunity identification happens in the case company. Emphasis was put to report empirical part of the research as accurately as possible as well elaborating used decision-making criteria's as well the idea concept evaluation process to enhance internal validity of the research. Finally, the researcher informed the key employees from the case company of the research results.

However, the external validity of current research is hard to assess since the empirical material has been gathered mostly from the case company. Interviews were carried out with three other industrial companies, but since the benchmarking interviews were used to gather information rather than test findings of this study, the results of this study are hardly applicable to other industries and contexts. Also, since the empirical material did not include customer and user insights, it can be argued that identified strategic digital service opportunities might not be correct. It is possible that the case company employees have failed to understand customer and user value, and seemingly correct identification of opportunities is faulty due to wrong data sources. Still, existing theory from industrial domain was used to construct the front end of digital service innovation phases and the digital service ideation framework, which does enhance the external validity within an industrial context.

Generalizability of current study is findings is somewhat two folded. For example, digital service ideation framework was first synthesized from existing literature and then refined

based on empirical findings. Therefore, the ideation framework is not generalizable as it is – it is certain that some customers encompass different roles and stakeholders and lifecycle of different types of industrial equipment are not similar. However, the actual methodology of how to use and construct the ideation framework, or to organize the front end of digital service innovation, could be generalizable to other manufacturing companies. Therefore, the findings which are based on outputs of digital service innovation process (i.e. digital service idea concepts, identified strategic opportunities and development roadmap) are highly case sensitive and therefore not generalizable across industries. After all, these digital service opportunities were identified only for one case company and only one front end project was studied.

The chosen research methodology had a negative influence on the reliability of the research – the role to be an involved researcher provided great access to needed information but also has made the findings subjective of researchers own interpretations. It would be difficult to repeat the research settings and come up with the same findings due to it is somewhat difficult to tell, which part the researcher truly has played in the empirical section of this research. Also, the research settings of this thesis were somewhat unique, which makes it difficult to test if the results are repeatable.

Yin (2003) notes that reliability of research is also based on good documentation and reporting of a research process. In the present research, the used research methods, persons behind the decisions and how the case company made decisions, was reported in details. However, due the high novelty and sensitivity of the topic in the case company, it was not possible to record the interviews nor the workshops. Therefore, data gathering of people's reactions and comments was based on the limited capability of the researcher to take notes, and it was impossible to fully transcript the process. The limitations of current research show some avenues for future research, the next chapter elaborates.

6.3 Further research areas

In this research opportunity identification for industrial digital services was studied from the highly explorative angle in one front end project. Digital service opportunities proved to be a novel research area, and it was necessary to define the manageable scope to meet the given timetable. Therefore, a clear theme for future research, which arises from limitations of current research, is to assess further how digital service delivered along an industrial equipment does affect to competitiveness the total offering using customer and user interactions. The current study was not able to provide a clear answer since the empirical examination did not include customer and user interactions.

Another interesting research avenue is related to the digital service idea concepts themselves. Peer to peer -class of digital service idea concepts was left out of this research scope because these digital service idea concepts did not have a dependency of the core physical equipment. Creating this kind of digital services, which could facilitate exchange

between third parties and peers, could be an interesting strategic opportunity for industrial manufacturers and might also be possible to realize by some third party alone. Indeed, third parties might be able to create faster more radical digital service offerings, since for them utilizing agile innovations methods might not be such an issue as for the case company of this research. Digital service development by third parties disrupted mobile phone business, so it would be interesting to explore what digital service opportunities third parties have in industrial context and if manufacturing companies could benefit from them as well.

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APPENDIX 1: OUTLINE OF THE WORKSHOPS

Workshop 1

9:00 Process overview & Background

9:45 Pre-work review

10:00 Raw ideation

14:00 Creating first ideas

15:00 Idea development

16:00 Closing

Workshop 2

12:00 Process overview

12:15 Idea introductions, Idea evaluations, Next steps

16:00 Closing

APPENDIX 2: PREWORK TEMPLATE

Offering name:________________________________ WS participant: ______________________

Offering and customer description:

Which is the physical product in the offering (i.e. out of which product the digital service is depended)?

Who are the users of the digital service, and for the product (i.e. customer and user)?

Figure, or illustration, of the digital service's role in the offering.

What is the key benefit for you as the customer, or the user of the digital service (i.e. value proposition)?

How does the digital service work in practice (e.g. how to access the service, how to use it, what does it do)?

APPENDIX 3: IDEA DEVELOPMENT TEMPLATE